THE SEA-MANS PRACTICE,

CONTAINING

A FUNDAMENTAL PROBLEME IN

NAVIGATION,

Experimentally verified:

NAMELY,

Touching the Compaſs of the *EARTH* and *SEA*, and the Quantity of a Degree in our *Engliſh* Meaſures.

Alſo an Exact Method or Form of keeping a Reckoning at *SEA*, in any kind or manner of Sailing.

With certain *TABLES* and other *Rules* Uſeful in *Navigation*, As alſo in the *Plotting* and *Surveying* of *Places*. The *Latitude* of the Principal Places in *ENGLAND*. The finding of Currents at *SEA*, and what Allowance is to be given in reſpect of them.

THE EIGHTH EDITION.

By RICHARD NORWOOD, Reader of the *Mathematicks*.

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THE SEA-MAN'S PRACTICE

IN NAVIGATION.

Experimentally treated:

NAMELY,

Touching the Compass of the EARTH

And the Rhumbs and the Quarters and Points

Also an Exact Method or Form of Keeping a Reckoning at Sea, in any kind or manner of Sailing

With Certain Rules and Tables

BIBLIOTHECA · BODLEIANA ·

To the Right Honourable,

ROBERT

Earl of *WARWICK*,

Baron of *LEES*, &c.

Right Honourable,

ALthough the knowledg and practice of the Art of Navigation be of late years grown to a far greater Perfection, than it can appear to have had in any former Age; and by that means, the World, and all the parts thereof, have been further discovered, yea, Sailed round about: the Traffick and Entercourse of several Nations, how remote soever, facilitated: knowledg in divine and humane things divulged: and (which, as I conceive, is of most importance, seeming as yet to be the principal scope of the Divine Providence in discovering those Mysteries) the light of the glorious Gospel of *Christ*, being the mighty power of God unto Salvation, is extended to those silly Captives of Sathan in *America*, by means of those many Plantations we have amongst them; which Plantations (even from their first breathing) have received no small furtherance from your Noble favour and bounty, as I know by my own Experience in that where sometimes I was, and have understood no less by others in the rest.

Yet

Yet notwithſtanding this notable growth and daily exerciſe of the Art of *Navigation*, it ſtill remains imperfect in ſome points. For whereas the practice thereof doth eſpecially conſiſt in the knowledg of Latitudes, Courſes, and Diſtances; the way of finding diſtances at Sea, namely, by the Log and Line, is rather opinionative and conjectural then certain, being grounded upon this ſuppoſition, that the compaſs of the World in any great Circle is 21600 *Italian* miles(as they call them) and that ſuch an *Italian* mile contains 1000 Paces, and every of thoſe paces five *Engliſh feet*: and according to theſe meaſures they divide their Log-line,and keep their account of the ſhips way at Sea.

Having therefore by an Experiment which I made a year ſince, found more neerly the compaſſe of the Earth, and the quantity of a Degree on the ſame in our known meaſures, and applyed it to uſe in *Navigation*, in this Treatiſe following: and further added ſome other ſuch things as I conceived to be wanting in the practice of that Art: I have preſumed to preſent it to your Lordſhip, as well becauſe by your knowledg in *Navigation*, and the experience you have had in your Honorable enterprizes at Sea, you are well able to judg of it: as alſo being confident that according to your noble diſpoſition you will favourably accept thereof, though otherwiſe of it ſelf unworthy. The moſt High God ever bleſſed and glorious,multiply unto your Honour all his bleſſings in *Chriſt Jeſus*.

Your Honours in all due Obſervance,

RICHARD NORWOOD.

To the Reader.

THe Circuit of the Earth and Sea (as the circumference of every Circle) contains 360 Degrees, by which degrees the distances thereon are measured, so that the knowledg of the quantity of such a Degree in our known measures, is a fundamental principle in Cosmography and Navigation, as upon which is grounded the reckoning of the ships way or distance run. For though a Mariner being in his Voyage on the vast Ocean, have sometimes three things to certifie him where he is, and how to shape his Course to his desired Port, namely, his Latitude, Course, and Distance; and sometimes a fourth, namely some neer conjecture of his Longitude by the Variation, or otherwise; yet oftentimes (as in close weather) he hath nothing but his course and distance; otherwhiles only his Latitude and Distance is his chief guide in falling with his intended Port. I know it is usual to allow neer 7 Fathoms or 41⅔ feet to a knot, and so many of those knots as run out in half a Minute so many miles they account the Ships way to be in an hour. And if in half a minute she run 41⅔ feet, then in 60 minutes, or an hour, she runs 5000 Feet; and thus they account 5000 English feet, or 1000 paces to be a mile, and 60 of those miles to be a Degree, such as the whole circumference in any great Circle is 360. But how is this known to be true? If it be answered, that it is known to be so by Experience, then I would know further by what Experiment this was found to be so? Where, and by whom made? I press this so much the rather, because I am perswaded we have at this day as many excellent Navigators in this Kingdome, and as great Voyages performed, as from any other place in the World, and I should be glad to hear of the experimental resolution of this Problem by some of them, though it were but in running 8 or 10 degrees neer the Meridian: for so I doubt not but that which I have here written thereof would receive further confirmation and better entertainment then haply it will now, being so much different from the common opinion, and the Arts of Navigation and Cosmography would be much more perfected in short time. For one errour (as a fruitful Mother) is oftentimes the cause of more, and so the removing of one is the occasion of removing others, especially, when they do mutually support one another: As we shall here shew how the Error in the Projection and use of the Common Sea-chart, is supported by this Errour of accounting only 300000 of our Feet to a Degree; and this in like sort upheld by that, so that they will stand or fall together. And surely that had fallen long since, being so manifestly convinced; if it had not been upheld by this. For the confuting of that, (I mean the common Sea-chart) it was sufficient to know that the Earth and Sea make one Spherical body, but in disproving and rectifying this, it is necessary to know

moreover

moreover what is the quantity of that Spherical body: and to that end it was necessary to make a sensible application of our known Measures, to a determined part of the whole, that so the quantity of that determined part being known, and the proportion thereof to the whole, the quantity of the whole might also be discovered. And this I have endeavoured in the experiment following, which if I have not handled so exactly in all points as some would desire: That requiring more time and charg (then I could well bestow) yet I doubt not but it will be found that I have come very neer the Truth. Some happily will censure me for being my self at the expence to make such an Experiment. But I was as frugal in it as I could, adding pains and industry to save expence. I came up in ten or eleven days, and had other necessary occasions to lead me from the one place to the other, and did this as a thing falling opportunely in my way. But indeed (as in all other parts of Learning) so in the Mathematicks, especially in their application, or middle Mathematicks (as some call them,) it is necessary with Speculation to joyn actual and experimental practices; the former being empty and uncertain without these. It is true, that the Mathematicks afford large fields of delightful Speculations, wherein a man might walk far with much pleasure: But if from so many fair Flowers he bring home no honey, or from such larg fields no sheaves: I mean, if he bring not those Speculations to some useful practices, neither himself nor others are like to receive much fruit by them. But this indeed cannot be effected without more labour and difficulty, yea sometimes it requires Mechanical and Bodily exercises, which some esteem too mean and servile for so noble an Art. But for mine own part, I acknowledg to have had my living and maintenance by the Mathematicks, and not by Speculation only, but rather by my practice therein; and therefore also I desire (what in me lies) to make them fruitful to my self and others: And to that end have spent in some principal parts of the Mathematicks, neer as much time and means in experimental Practices and Conclusions, as in the Speculation. Moreover, considering that this particular Experiment was proposed above thirty years since, by our Country man Mr. Edw: Wright, to invite some to the tryal of it, as a thing which he would have done himself, if he had found such furtherance and opportunity as he desired, which it seems he did not, nor any other since that time. Rather then so noble and so necessary a Problem should longer rest unresolved, I took the opportunity offered, hoping it may be an occasion to whet on some others to do the like. This with some other things which I conceived to be wanting in the practice of Navigation, I have handled in this ensuing Treatise, which I commend to your friendly acceptance, Farewel.

July the first, 1636.

THE SEAMANS Practice.

CHAP. I.

The common opinion touching the Compass of the Earth, and quantity of a Degree of the same.

IT is a common received opinion in *England*, (and the like is in other places) that allowing 5 of our *English* feet to a Geometrical pace, 1000 of those paces make an *Italian* mile, and 60 of those miles in any great Circle upon the Spherical Surface of the Earth or Sea make a Degree; and thus it is supposed, that a Degree contains 60 miles, or 60000 paces, or 300000 of our *English* feet, and by such miles do Mariners in their Voyages by Sea keep their Reckonings: And because the whole circumference of a Circle is 360 Degrees, therefore the compasse of the Earth, according to this opinion should be 21600 such *Italian* miles, or 21600000 paces, or 108000000 of our *English* feet. Whence this opinion came, or upon what experiment it should be grounded, I cannot certainly say; It may seem to be taken, or rather mistaken

miſtaken from *Ptolomy*; who ſaith, there are 500 *Stadiums* in a degree, the ſame was before affirmed by *Marinus Tyrius*, of whom *Ptolomy* ſpeaking in the 11 Chapter of his firſt Book of *Geography* hath theſe words, *Sed in hoc quoque recte ſentit partem unum qualium eſt circulus maximus trecentorum ſexaginta, quinginta in terra conſtituere Stadia, id enim confeſſis dimenſionibus conſonum exiſtit.* Now a *Stadium* not only amongſt the *Greeks*, but as appears by *Herodotus*, amongſt all other Nations of *Aſia* and in *Egypt*, did conſiſt of 600 feet, or 100 *Orgyas*, an *Orgya* containing ſix feet or four cubits, as our fathom doth: the ſame alſo is teſtified by *Suida* and others: So that a Degree containing 500 Stadiums, and every Stadium 600 feet, it follows that a Degree muſt contain 300000 feet, exactly agreeing in number with the common received opinion in *England*, which therefore may ſeem to be hence derived, and would alſo receive much confirmation hereby (he being an Author of ſuch approved credit) if it could be approved that our *Engliſh* feet were exactly equal to the *Egyptian* or *Alexandrian* foot, where *Ptolomy* wrote. Otherwiſe that being true, that ſo many of their feet make a degree, it will follow, that if ours be greater, there be fewer of them contained in a degree; if leſſer (as undoubtedly they are) there muſt be more of them contained in a Degree.

Philander in his Commentary upon the third Chapter of the third Book of *Vitruvius*, hath expreſſed the quantity of the ancient *Roman* foot, where (by a competent allowance for the ſhrinking of the paper being printed wet) it may probably be gathered that it was ſomething longer then our *Engliſh* foot. But the *Alexandrian* and *Egyptian* foot was much greater, for according to *Heromechanicus*, 5 *Alexandrian* feet were equall to 6 *Roman* feet: ſeeing then the ancient *Roman* foot was ſomething greater then ours, the *Alexandrian* foot muſt needs be much greater then ours. So that whereas *Ptolomy* ſaith there are 500 *Stadiums* in a degree, and as we have ſhewed a *Stadium* did conſiſt of 600 feet, theſe being *Egyptian* or *Alexandrian* feet, as it is moſt probable, being the place where *Ptolomy* lived; there muſt be a far greater number of our feet in a *Stadium*, and ſo in a degree; whence

it

it is evident, that there is no ſufficient footing for this common opinion in the aſſertion of *Ptolomy*.

Neither doth the practice and experience of Mariners in their Voyages at Sea prove it; for there is no reckoning or experiment at Sea ſet down by any (that I have ſeen) to confirm it. And though it be true, that in ſailing between two places that lie neer to one and the ſame Parallel, they ground their reckoning chiefly upon this ſuppoſition, that 300000 of our Engliſh feet make a Degree, yet can they ſeldome or never by thoſe reckonings diſcern the Error, the rather for that they have been, and for the moſt part are ſtill kept upon the Plain or Common *Sea-Chart*, which makes a Degree in any Parallel equal to a Degree in the Equinoctial; and ſo makes a Degree in any Parallel to contain 300000 feet: And it is true, that in ſome Parallel a Degree doth contain only 300000 of our Engliſh feet; namely, about that Parallel which is in Latitude 35 degrees (as we ſhall further ſhew hereafter) neer unto which have the principal of our Eaſtern and Weſtern Voyages been made. And thus, though this opinion of 300000 feet in a Degree, and the projection of the *Common Chart* be both erroneous; yet becauſe the error of the one doth ſomething ſalve the other, they could not be ſo eaſily diſcerned by Experience only.

This opinion of 300000 *Engliſh* feet to a Degree, may ſeem alſo to be ſomething confirmed by an Obſervation made by our Countrey-man Maſter *Edward-Wright*, upon Mount *Edgecumbe* neer *Plimouth*, of the Semidiameter of the Earth, which he hath ſet down in his Book, *Of the Correction of Errors in Navigation*, Chap. 15. where he finds the *Semidiameter* to be 18312621 of our *Engliſh* feet, whence it may be gathered, that in a Degree of a Great Circle of the Earth, there ſhould not be full out 320000 of our feet; but the way by him then uſed, though it was very fit for the end whereunto he there applies it; namely, to find the dipping or depreſſion of the apparent Horizon beneath the true, according to the heighth of the eye above the water; yet will it eaſily be granted to be

no exact way for finding the *Semidiameter*, and consequently the Circumference of the Earth, or the quantity of a Degree on the same; and so he says there, that he used that way, because he wanted opportunity to put in practice a more exact way. Wherefore for the further Satisfaction of my self and others in this Point, and chiefly for the necessary use it hath in the Practice of *Navigation*, I have made the Experiment following, that so the quantity of a Degree, and of the whole Compasse of the Earth might at least-wise be nearly known in our *English* measures.

CHAP. II.

An Experiment made for finding the quantity of a Degree, and so the Circumference of the Earth and Sea in our known measures.

HAving occasion to be in the City of *York*, about the beginning of *June*, *Anno* 1635. I made there several Observations of the Meridian Altitude of the Sun, the last of which was made the eleventh day of *June*, the Skie was every of those dayes something over-cast at noon, yet not so much but that an Observation might be made to neer scantling: And because the last of those Observations is most fit for the present occasion, and that day was as clear as any of the other, we will here especially make use of that, being as followeth.

Upon the eleventh of *June* 1635. I made an Observation near the middle of the City of *York*, of the Meridian Altitude of the Sun, by an arch of a *Sextant* of more than five foot Semidiameter, and found the apparent Altitude of the Sun that day at noon to be 59 degrees 33 minutes.

I had also formerly upon the eleventh day of *June*, *Anno* 1633. observed in the City of *London*, near the Tower, the apparent

apparent meridian Altitude of the Sun, and found the same to be 62 deg. 1. min.

And seeing the Sun's declination upon the eleventh day of *June* 1635, and upon the sixth day of *June* 1633, was one and the same without any sensible difference; and because these Altitudes differ but little, we shall not need to make any alteration or allowance, in respect of Declination, Refraction, or Parallax: Wherefore substracting the lesser apparent Altitude; namely, 59 degrees 33 minutes, from the greater 62 degrees 1 minute, there remains 2 degrees 28 minutes, which is the difference of Latitude of these two Cities; namely, of *London* and *York*.

Also by the aforesaid Observation made in *York*, it appears, that the Latitude of that City is 53 degrees 58 minutes almost.

But to our purpose; Coming at that time from thence to *London*, I further found by measure, that the Parallel of *York* is from the Parallel of *London*, 9149 Chains; every Chain being six Poles, and every Pole $16\frac{1}{2}$ of our English Feet; that is, every Chain ninety nine Feet. (After what manner I found this to be so, we shall further expresse hereafter:) But thus, as I say, I found that *York* is more Northerly than *London*, by 9149 Chains: And before we have noted that these two places differ in Latitude 2 degrees 28 minutes: therefore it follows, that 2 degrees 28 minutes of the meridian on the Earth and Sea, is equal to 9149 Chains. And if accordingly we would know how many of these Chains are contained in one Degree, we may find that by the Rule of Proportion, first reducing the Degrees into minutes, and then say,

If the difference of Latitude	148 *co. ar.*	7. 82974
give such a number of Chains.	9149	3. 96137
Then one Degree, that is	60	1. 77815
gives of such Chains	3709	3. 56926

and somewhat more, namely, five Feet, which reduced into Feet, make 367196. that is, 367200 Feet in a Degree, lacking four Feet, which here we regard not.

Thus then, according to this experiment, it is evident, that one degree of a great Circle measured on the Earth is near 367200 feet, which in our poles of 16½ feet, is 22254 poles, and about one half, and these reduced into Furlongs at 40 poles to the Furlong, make 556 Furlongs and 14 poles: and lastly, these reduced into our English miles, of 8 Furlongs to a mile, make 69 miles and 4 furlongs 14 poles, that is 69½ miles and 14 poles, in a Degree.

And hence, according to the most approved *Hypothesis* of the *Sphericity* of this *Terrestial Globe*, we may find the compasse of it as followeth. But first, you may note that we speak not here of the compasse of the earth in any parallel or lesser circle described upon any side thereof, (that being various according to the different distance of those circles from their poles) but of the compasse taken in the middle or greatest thickness of the Globe, namely, in any great Circle, such as divide the whole Globe into two equal parts, of which kind are the Equinoctial and all Meridians, &c. this being properly the *Perimeter* or *Compasse* of a *Spherical Body*.

Now seeing a Degree is the 360 part of the circumference of a Circle (for any circumference being divided actually or by supposition into 360 equal parts, those parts are called degrees) if we can find how many Feet, paces, miles, or other known measures are contained in one of those degrees, then shall we easily conclude how many of the same known measures are contained in the whole Circumference: But by the former experiment we find, that in one degree of a great Circle on the *Spherical Superficies* of the earth there is contained 367200 feet, therefore it is evident that 360 times 367200 feet, is the compasse of the whole; wherefore multiplying 367200 by 360, the product is 132192000 feet, which reduced into poles is 8011636, and these reduced into Furlongs, are 200290 Furlongs 36 poles: and lastly, these reduced into miles, are 25036 English miles, and somewhat more, for the circuit of the Earth and Sea.

If further we desire the Diameter and Semidiameter of the Earth,

Earth, forasmuch as it is proved by *Archimedes*, that the proportion of the circumference of a Circle is to the Diameter thereof, almost as 22 to 7: Therefore by the Rule of Proportion, as 22 to 7: So is the Circumference of the Earth, to the Diameter thereof: So that multiplying the Circumference of the Earth, namely, 132192000 feet by 7. and dividing the Product, namely, 925344000, by 22 the quotient, namely, 4206191 is the Diameter of the Earth in Feet, the half whereof, namely 21030545 feet, is the Semidiameter of the same, being 21 millions of feet, and somewhat more: these reduced into *English* miles, as before we did the Circumference, shew the Diameter of the Earth to be 7966 miles, and somewhat more, and the Semidiameter 3983. And thus we have the Circumference, Diameter, and Semidiameter of the Earth, as also the quantity of a Degree of the same Circumference in known measures of Feet, Furlongs, and Miles, *&c.* There are only two things here, which may seem doubtful; namely, the Experiment it self, and the *Hypothesis* of the Sphericity of this *Terrestial Globe* consisting of the Earth and Sea; for these being admitted, the measures thence reduced as before, will necessarily follow.

Now touching the Experiment, I confesse, that to have made it so exactly as were requisite, and in all points so as I shall shew in the Chapter following, would have required much more time and expence than mine ability would reach unto; Yet having made Observation at *York*, as aforesaid, I measured (for the most part) the way from thence to *London*; and where I measured not, I paced; (wherein through Custome I usually come very neer the truth) observing all the way as I came, with a Circumferentor all the principal Angles of position or windings of the way (with convenient allowance for other lesser Windings, Ascents, and Descents) and these I laid not down by a Protractor after the usual manner, but framed a Table much more exact and fit for this purpose, as we shall hereafter shew; so that I may affirm the Experiment to be neer the truth.

Touching

Touching the *Hypotheſis* that the Earth and Sea make one Spherical or round Body, it is generally agreed upon by all the principal Philoſophers, Aſtronomers, Geographers, and Navigators, ancient and modern, ſome reaſons demonſtrative for the confirmation thereof may be theſe.

Firſt, The Eclipſes, eſpecially of the Moon, which are cauſed by the ſhadow of the Body of the Earth being interpoſed between the Sun and the Moon, and for as much as this ſhadow doth fall upon the Moon, alwayes and on every ſide circular, and ſo appears to us, it is manifeſt by the Opticks, that the Earth from whence it proceeds is a Spherical Body.

Secondly, Likewiſe the Eclipſes of the Sun, which are cauſed by the interpoſition of the Moon between the Sun and thoſe places where it appears Eclipſed; I ſay, it could not be determined when and in what place ſuch an Eclipſe ſhould appear, and where not, if the form of the Earth were not known; but ſeeing the places where ſuch Eclipſes happen, and where not, may be and are uſually determined, and that upon this ground; that the Surface of the Earth is Spherical, it is thence alſo ratified to be a truth.

Thirdly, the Sun, Moon and Stars do riſe and ſet, and are upon the Meridian ſooner to thoſe that are reſident in the Eaſtern parts, than to others more Weſterly, and that in a proportion anſwerable to the roundneſs of the Earth, as the Planets and Stars are upon our Meridian at *London* ſooner by almoſt four hours, than they are to thoſe that inhabit *Summer Iſlands*, and the confines of *Virginia* and *New England*: And ſo in *Eaſt-India*, and other Eaſtern Regions, the Sun and Stars are ſooner upon their Meridian than upon ours; which is manifeſt to be ſo, as by other reaſons, ſo eſpecially by the Eclipſes of the Moon: for an Eclipſe of the Moon hath not in it ſelf any diverſity of time, being at one and the ſame inſtant without reſpect of places, yet becauſe in the Eaſtern parts the day is begun, and it may be far ſpent before it begin in places far Weſterly, therefore ſuch an Eclipſe may appear to the Eaſtern Inhabitants towards the end of their night, which to the Weſtern appears

pears in the beginning or middle of the ſame night with them, and ſo the difference will be more or leſſe, according to the different diſtance of thoſe places in Longitude.

Fourthly, Furthermore we ſee, that going or ſailing to the Northwards, we have the Artick Pole and Northern Stars more elevated, and the Antartick Pole and Southern Stars more depreſſed, the Elevation Northerly increaſing equally, with the depreſſion Southerly, and either of them proportional to the diſtances which we go: The like happeneth in going to the Southwards. Beſides the Oblique Aſcenſions, Deſcenſions, Occultations, Emerſions, and Amplitudes of Riſing and Setting of the Sun and Stars, in every ſeveral Latitude, agreeable to the *Hypotheſis* of the Earth's Sphericity. All which could not be ſo, if the Earth were of any other than of a Spherical form.

Fifthly, So if we ſtand upon the Sea-ſhore, and ſee a ſhip far off under Sail, making towards the Land, at firſt we ſee only the Top-ſails or higheſt parts, and withall do manifeſtly behold the convex Superficies of the Sea, as it were raiſed and interpoſing her ſelf between our ſight and the Hull, or lower parts of the Ship, till ſhe approacheth nearer, and this uniformly, every wayes alike, and proportionably to the ſeveral diſtances; which doth evidently demonſtrate the Spherical roundneſſe thereof.

Sixthly, And laſtly, (to add no more) the Navigations of theſe later times make it apparent, thoſe eſpecially that have been made round about the World, as thoſe two Voyages by our famous Countrey-men Sir *Francis Drake*, and Mr. *Thomas Candiſh*, both which ſeverally ſailing from our Coaſts to the *Weſt-Indies*, and paſſing the Streights of *Magellane*, continued their courſe Weſterly, till they came into thoſe parts, which are from us to the Eaſt-wards; namely, to the *Eaſt-Indies*, and ſo ſailed ſtill Weſterly till they came to *Cape bon Eſperance*, and thence returned into *England*: having ſailed about the whole Terreſtial-Globe, they found nothing by their obſervations or Reckonings diſſonant from the uniform *Sphericity* thereof in

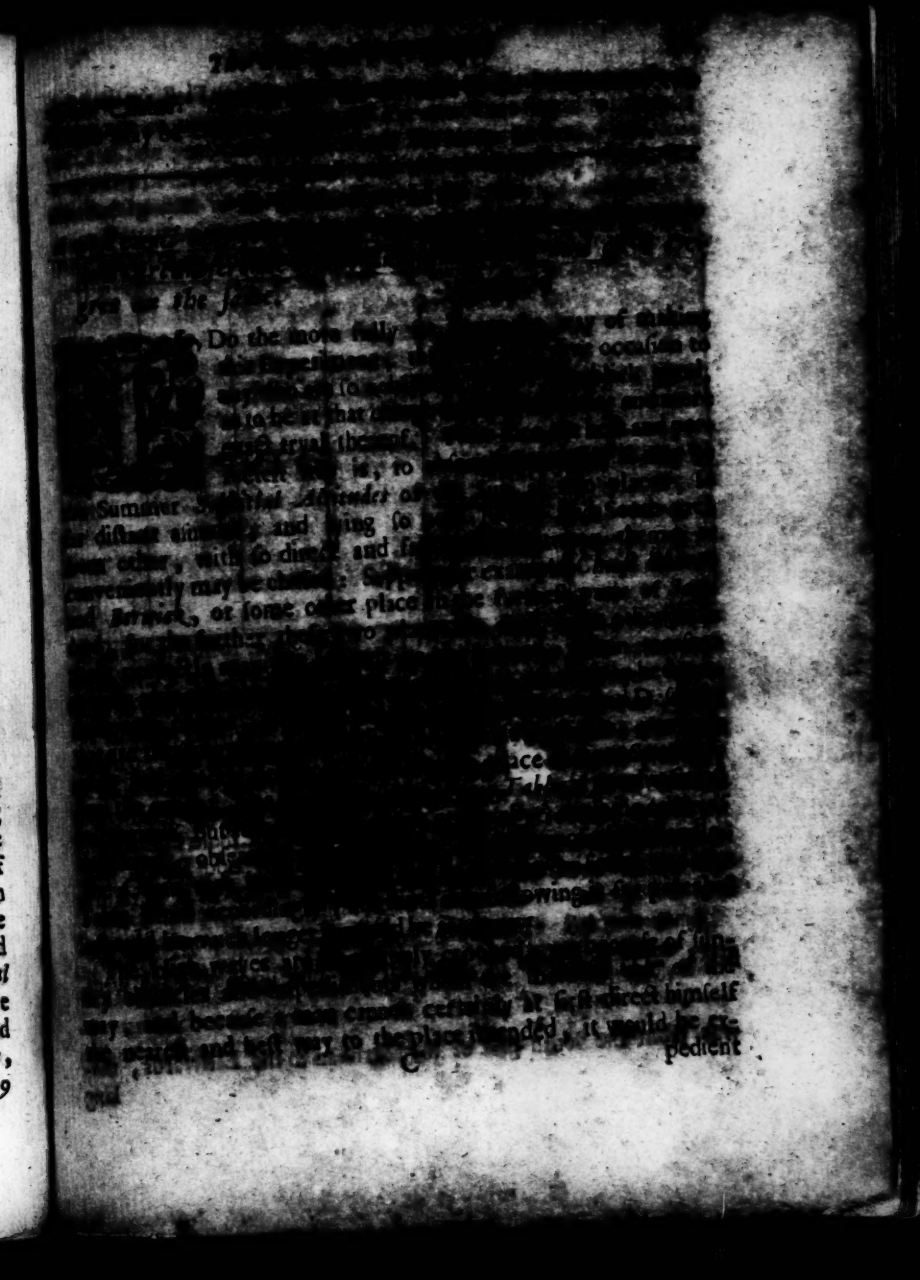
in all its parts. That they came ſhort in the number of dayes, one, or reckoned the time of their abſence leſſe by one day and a night than they which remained at home; this further confirms the thing in hand.

Yet whileſt we ſpeak here of the Roundneſſe of the Earth and Sea, we intend it not ſo ſtrictly as if it were a thing turned round without any inequality in its Superficies: But as a Bowl or Ball though it have ſome duſt or ſmall grains of ſand cleaving thereto, may ſtill be ſaid to be round: So, though the Land, Hills, and Mountains be ſomewhat raiſed above the Spherical Superficies of the Sea, and if there ſhould be alſo ſome Valleys or Bottoms more depreſſed; yet ſeeing the greateſt of theſe inequalities have ſcarce any ſenſible proportion to the whole, we may well affirm the whole to be round.

The relations made of the prodigious height of ſome Mountains, as to be 60 or 70 miles high, if it be underſtood of their perpendicular or direct height, are fabulous; the Mount *Atlas* recorded by ſome of the Ancients, to reach up almoſt to the Moon, and to be as it were a Pillar for the Heavens to reſt upon, being meaſured Geometrically by *Eratoſthenes*, the perpendicular or upright height from the top thereof to the Valleys beneath, was found not to exceed ten *Stadiums*, which of our *Engliſh* meaſures is little more than a mile and a quarter, a *Stadium* not much differing from our Furlong; and the like might be ſhewed of others.

But if we admit the higheſt Mountain to riſe perpendicularly above the Spherical Superficies of the Sea two miles, yet ſeeing the Diameter or whole thickneſſe of the Earth, is, as we have before ſhewed, 7966 miles, this exorbitancy or difference of two miles is of ſmall moment; yea, if there were any Mountain eight miles in height upright, yet this compared with the whole thickneſſe of the Earth, is little more than one thouſand part thereof; therefore we may conclude, that this *Terreſtial Globe*, conſiſting of the Earth and Sea, is *Spherical*. We come in the next place to ſhew by what way of meaſuring we found the Parallel of *York* to be diſtant from the Parallel of *London*,

9149



in all its parts. That they came ſhort in the number of dayes, one, or reckoned the time of their abſence leſſe by one day and a night than they which remained at home; this further confirms the thing in hand.

Yet whileſt we ſpeak here of the Roundneſſe of the Earth and Sea, we intend it not ſo ſtrictly as if it were a thing turned round without any inequality in its Superficies: But as a Bowl or Ball though it have ſome duſt or ſmall grains of ſand cleaving thereto, may ſtill be ſaid to be round: So, though the Land, Hills, and Mountains be ſomewhat raiſed above the Spherical Superficies of the Sea, and if there ſhould be alſo ſome Valleys or Bottoms more depreſſed; yet ſeeing the greateſt of theſe inequalities have ſcarce any ſenſible proportion to the whole, we may well affirm the whole to be round.

The relations made of the prodigious height of ſome Mountains, as to be 60 or 70 miles high, if it be underſtood of their perpendicular or direct height, are fabulous; the Mount *Atlas* recorded by ſome of the Ancients, to reach up almoſt to the Moon, and to be as it were a Pillar for the Heavens to reſt upon, being meaſured Geometrically by *Eratoſthenes*, the perpendicular or upright height from the top thereof to the Valleys beneath, was found not to exceed ten *Stadiums*, which of our *Engliſh* meaſures is little more than a mile and a quarter, a *Stadium* not much differing from our Furlong; and the like might be ſhewed of others.

But if we admit the higheſt Mountain to riſe perpendicularly above the Spherical Superficies of the Sea two miles, yet ſeeing the Diameter or whole thickneſſe of the Earth, is, as we have before ſhewed, *7966* miles, this exorbitancy or difference of two miles is of ſmall moment; yea, if there were any Mountain eight miles in height upright, yet this compared with the whole thickneſſe of the Earth, is little more than one thouſand part thereof; therefore we may conclude, that this *Terreſtial Globe*, conſiſting of the Earth and Sea, is *Spherical*. We come in the next place to ſhew by what way of meaſuring we found the Parallel of *York* to be diſtant from the Parallel of *London*,

9149

9146 Chains. And so hath the distance of the Parallels of two Places may be exactly measured.

CHAP. III.

A most exact way for finding the quantity of the Diameter and Circumference of the Earth and Sea, and of a Degree on the same.

I Do the more fully set down the way of making this Experiment, that so I may give occasion to any who are so nobly minded for a publick good, as to be at that charge to make a further and more exact tryal thereof. Now then, the best and perfectest way is, to observe so exactly as may be the Summer *Solstitial Altitudes* of the Sun at two places, so far distant asunder, and lying so near North and South each from other, with so direct and fair a way between them, as conveniently may be chosen: Suppose for example *Christ Church* and *Berwick*, or some other place in the furthest parts of *Scotland*, for the further these two places are each from other, the more perfectly may this business be performed. Then measure as truly as is possible, and set down in a Book, all the way between those two places, with all the Windings, Ascents and Descents that are therein, whereby with help of the ensuing Table, you may easily and exactly find how much the one place is more Southerly than the other. For this purpose the *Plain Table* is not the fittest Instrument, but rather a *Theodolite* or *Reracter*, or some other of that kind, observing diligently the Variation of the Needle. The Chain may be six poles long, or rather 100 feet, and the Table fitted accordingly (but the Table following is for poles) if it should be much longer it would be too heavy.

The High-wayes are commonly crooked, yet because of sundry obstacles and impediments which are incident out of the way, and because a man cannot certainly at first direct himself the nearest and best way to the place intended, it would be expedient

pedient to measure the distance as aforesaid; First, in the High-wayes leading from the one to the other, and then in the nearest and best way that could be chosen between them; and so if any notable Errour happen in the one, it may be discovered and amended in the other. The form which I observed in setting down the measures and angles, was according to this Example.

Deg.	Distance.	North.	South.	East.	West.
SE 31	[illegible]				
SE 20	[illegible]				
SE 13	[illegible]				
SE 13	[illegible]				
SW 02	[illegible]				
SE 05	[illegible]				

It is to be understood, that the Table here following was before calculated to serve instead of a *Protractor*, for a Circumferentor, or other Graduated Instrument, and for a Chain of three Poles, which for the most part I use; yet it may very well be applied to a Chain of six Poles, (as in this business it was) reckoning every Chain to be two, &c. And thus for every ten Chains of six Poles to a Chain, I make two strokes, signifying two Chanes or 20 Chains; and if there be any odd Chains, for those I set a figure in another line next below; and if moreover any odd Poles, whether one or two, for those I set another figure in a third line below.

Thus the last entrance before-going, being *S E.* 05 Degrees, [illegible] signifies that the Line upon which I went, was from the South-part of the Meridian to the Eastwards, making

king an angle with the Meridian of 5 Degrees, the nine strokes signifie nine Changs, or ninety Chains, the figure 5 signifieth five Chains, and the figure 2 two Poles. So that it is to be read thus, South-Easterly 5 Degrees, 9 Changes, 5 Chains, and 2 Poles; and the like is to be understood of the rest. But for the most part having liberty of ground, I end the measure of every line, either with a whole number of Changes, or at least of Chains.

And this proceeding all day, towards the Evening, or when else I have time convenient, I reduce all these Distances, upon what Lines or Angles soever they be, to Distances of *North*, or *South*, *East*, or *West*, as here appears.

Deg.	*Distance.*	*North.*	*South.*	*East.*	*West.*
			2571	1545	
SE 31			2819	1026	
SE 2			1692	616	
			0169	062	
SE 13			2923	675	
SE 13			1754	404	
			1499		052
SW. 02			2690	235	
SE 05			0149	013	
			0020	002	
Chains.	571		16286	4578	052
	2		0	52	
Poles.	1715		16286	4526	

We will explain the last, and so the rest may easily be understood: *S E* 5 deg. | | | | | 5.2. Here because I have *S. E.* the numbers taken out of the Table must be put into the Columns entituled *South* and *East*. Then in the Table under 5 deg. I look for 9 Changes, and find against it 2690, and in the adjacent col. under the compl. thereof 235; and because *S E* 5 deg. is less then 45 deg. that is, nearer to the *South* then to the *E*. I put in the col. entituled *South* 2690, and in that entituled *East* 235; then again in

in the same Tabular Column under 5 degrees, I find against 5 Chains, (cutting off a Figure, because 5 Chains is but the tenth part of a Chaine) 149 to be put in the *South* Column, and 13 for the *East* Column.

Lastly, against 2 poles I find for the *South* Column 2.00 and for the *East* 2, and the like is to be understood of all the rest.

Now supposing this last to be a place, whose Distance and Situation from the first is required, I summe up the Columns severally, and of the *North* and *South* Columns substract the lesser from the greater, and so of the *East* and *West* Columns; and so it will appear how much *North* or *South*, and how much *East* or *West* the last place is from the first.

As in this Example, we find the last place to be to the Southwards of the first 1628 Poles, for the last figure may be cut off, being used in the Table, only for the more exactnesse, or may be made a Fraction, and so it is $1628\frac{6}{10}$ Poles; Likewise the last place is to the Eastwards of the first $452\frac{6}{10}$ Poles, and thus I proceed all the way.

Now touching the angles of ascent and descent of Hills and Valleys, to have observed them exactly, would have required more time and charge than I could of my self bestow; yet I made allowance for such of them as were of most moment, he that would observe them all, may either make two or three Columns more, or keep an account of them apart by themselves. But if he intend no further use of them, but to find the neareſt distance, he need not set them down, but make allowance for them on the ground, keeping his distance intire without Fractions.

As, admit I observe the ascent from a Valley to the brow of a Hill to be 14 degrees above the Level or Horizontal Line, and that measuring, I find the distance to be 30 poles; I turn to the Table, and under 14 degrees, and against 10 Chains, I find 2911, and 726, shewing that the Level or Horozontal distance from my Station to that Brow is only $29\frac{11}{100}$ Poles, and that the height of that Brow above the Level Line, is $7\frac{26}{100}$ Poles: But finding thus that the *Hypothenuſal* being 30, the

Baſe

Base or *level line* is but 29$\frac{11}{100}$ that is lesse by $\frac{89}{100}$, because I would avoid this Fraction, I add to the end of the foresaid measure of 30 poles upon a level Line, $\frac{89}{100}$ of a Pole, and then I may account my self distant from the place in the Valley where I made Observation 30 Poles in a *Level* or *Horizontal line*, and so set down the distance without a Fraction: the like is to be understood of all other Ascents and Descents.

Here followeth the Table.

°	1 d.	89 d.	2 d.	88 d.	3 d.	87 d.	4 d.	86 d.	5 d.	85 d.
1	300	5	300	10	300	15	299	21	299	26
2	600	10	600	21	600	31	599	42	598	52
3	900	15	900	31	899	46	898	63	896	78
4	1200	20	1200	42	1198	62	1198	84	1197	105
5	1500	26	1500	53	1497	78	1497	105	1494	131
6	1800	31	1799	64	1798	93	1796	126	1794	157
7	2100	37	2099	74	2097	110	2095	147	2093	183
8	2400	42	2398	84	2397	124	2394	168	2391	209
9	2700	47	2698	95	2696	140	2694	189	2690	235
10	3000	52	2998	105	2996	157	2993	210	2989	262
1	10	00	10	0	10	0	10	1	10	1
2	20	00	20	1	20	1	20	1	20	2

6 deg.

	6 d.		84 d.		7 d.		83 d.		8 d.		82 d.		9 d.		81 d.		10 d.		80 d.	
1	[illegible]		231		298		37		297		41		296		47		295		52	
2	597		462		596		74		594		84		592		94		590		104	
3	895		694		894		111		891		125		889		140		885		156	
4	1193		1262		1192		148		1188		167		1185		187		1182		208	
5	1492		157		1489		185		1485		209		1481		234		1477		260	
6	1790		188		1787		220		1782		251		1777		281		1772		312	
7	2089		220		2085		257		2080		292		2074		328		2069		365	
8	2386		251		2383		292		2377		334		2371		375		2364		417	
9	2686		283		2680		329		2674		376		2667		422		2659		469	
10	2984		314		2978		366		2971		418		2963		469		2954		521	
1	10		1		10		1		10		1		10		1		10		1	
2	20		2		20		2		20		3		20		3		20		3	

	11 d.		79 d.		12 d.		78 d.		13 d.		77 d.		14 d.		76 d.		15 d.		75 d.	
1	295		57		293		62		292		67		291		73		290		78	
2	590		114		586		124		584		134		582		146		580		156	
3	883		172		881		188		876		203		873		219		870		233	
4	1178		229		1174		250		1169		270		1164		290		1160		310	
5	1473		286		1467		312		1461		337		1455		363		1449		388	
6	1768		343		1760		374		1754		404		1746		436		1739		466	
7	2060		401		2055		436		2047		472		2038		508		2030		543	
8	2355		458		2348		500		2339		540		2329		580		2320		621	
9	2650		515		2641		562		2631		608		2620		653		2610		699	
10	2945		572		2934		624		2929		675		2911		726		2898		776	
1	10		2		10		2		10		3		10		2		10		3	
2	19		4		19		4		19		4		19		4		19		5	

	16 d.	74 d.	17 d.	73 d.	18 d.	72 d.	19 d.	71 d.	20 d.	70 d.
1	288	83	287	88	285	93	284	98	282	103
2	576	166	574	177	570	186	568	196	564	206
3	864	250	861	264	855	279	851	294	846	308
4	1153	332	1148	352	1140	372	1135	391	1128	411
5	1442	413	1434	438	1426	463	1418	488	1410	513
6	1730	496	1721	526	1711	556	1702	586	1691	616
7	2019	580	2008	615	1997	649	1986	684	1973	719
8	2307	663	2296	703	2282	743	2270	781	2255	822
9	2596	746	2583	791	2567	836	2552	880	2537	924
10	2884	827	2869	877	2853	927	2836	977	2819	1026
1	10	3	10	3	10	3	10	3	10	3
2	20	5	19	6	19	6	19	6	19	6

	21 d.	69 d.	22 d.	68 d.	23 d.	67 d.	24 d.	66 d.	25 d.	65 d.
1	280	107	278	111	276	117	274	122	272	127
2	560	215	556	224	552	234	548	244	544	254
3	840	322	834	337	828	351	822	366	816	381
4	1120	429	1112	449	1104	468	1096	488	1088	508
5	1400	537	1391	562	1380	586	1370	610	1360	634
6	1680	645	1669	674	1656	703	1644	732	1632	761
7	1960	752	1947	786	1932	820	1918	854	1904	888
8	2240	850	2225	899	2209	937	2192	976	2175	1015
9	2521	968	2504	1011	2485	1054	2466	1098	2447	1142
10	2801	1075	2782	1124	2761	1172	2740	1220	2719	1268
1	9	4	9	4	9	4	9	4	9	4
2	18	7	18	8	18	8	18	8	18	8

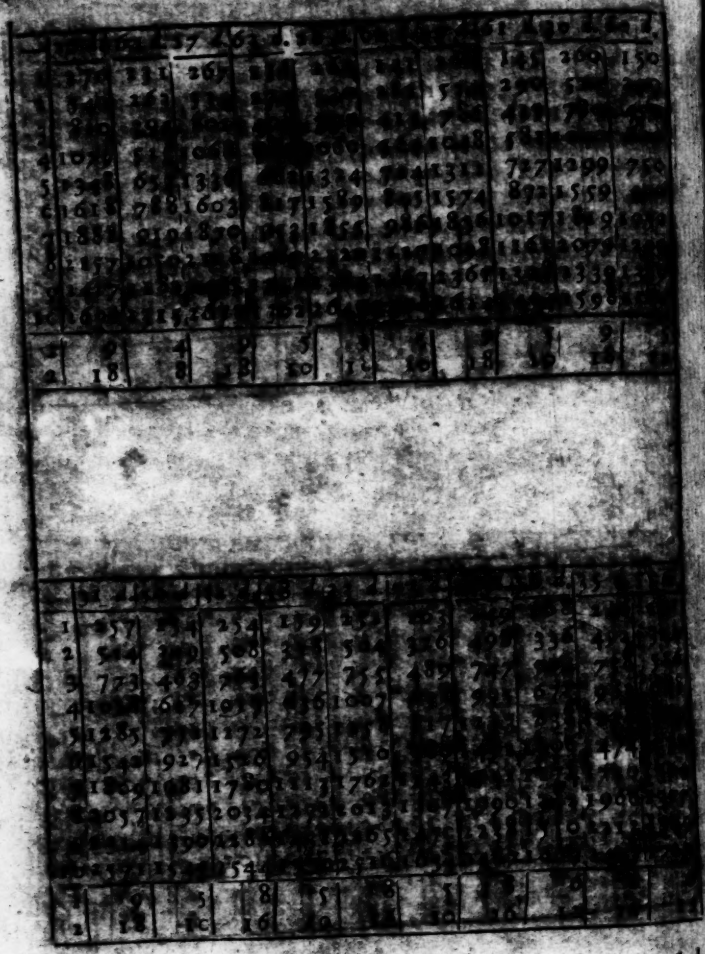
	25 d.	64 d.	27 d.	63 d.	28 d.	62 d.	29 d.	61 d.	30 d.	60 d.
1	270	131	267	136	265	141	262	145	260	150
2	540	263	534	272	530	282	524	290	520	300
3	810	394	801	408	795	423	786	435	780	450
4	1079	525	1068	544	1060	564	1048	581	1040	600
5	1348	657	1336	681	1324	704	1312	727	1299	750
6	1618	788	1603	817	1589	845	1574	872	1559	900
7	1888	919	1870	953	1855	986	1836	1017	1819	1050
8	2157	1050	2138	1089	2120	1127	2098	1162	2079	1200
9	2427	1182	2405	1225	2384	1267	2361	1308	2339	1350
10	2696	1315	2673	1362	2649	1408	2624	1454	2598	1500
1	9	4	9	5	9	5	9	5	9	5
2	18	8	18	10	18	10	18	10	18	10

	31 d.	50 d.	32 d.	58 d.	33 d.	57 d.	34 d.	56 d.	35 d.	55 d.
1	257	154	254	159	252	163	249	168	246	172
2	514	309	508	318	504	326	498	336	492	344
3	773	463	763	477	755	489	747	504	738	516
4	1028	617	1017	636	1007	653	995	671	983	688
5	1285	772	1272	795	1258	817	1243	838	1228	860
6	1542	927	1526	954	1510	980	1492	1006	1474	1032
7	1809	1081	1780	1113	1762	1143	1741	1174	1720	1204
8	2057	1235	2034	1272	2013	1307	1990	1342	1966	1377
9	2314	1390	2288	1431	2265	1470	2238	1510	2212	1549
10	2571	1545	2544	1590	2516	1634	2487	1677	2457	1721
1	9	5	8	5	8	5	8	6	8	6
2	18	10	16	10	16	10	16	12	16	12

36 d.

	36 d.	54 d.	37 d	53 d.	38 d.	52 d.	39 d.	51 d.	40 d	50 d.
1	176	170	240	180	236	185	233	189	230	193
2	486	352	480	360	472	370	466	378	460	386
3	729	528	720	541	709	555	699	567	690	578
4	881	705	960	721	945	739	932	756	920	771
5	1213	881	1198	901	1182	923	1165	944	1149	964
6	1456	1057	1438	1082	1418	1108	1398	1133	1379	1157
7	1699	1234	1678	1262	1654	1293	1631	1322	1609	1350
8	1942	1410	1918	1443	1890	1479	1865	1511	1839	1543
9	2185	1586	2157	1624	2126	1663	2098	1700	2069	1735
10	2427	1763	2396	1805	2364	1847	2331	1888	2298	1928
1	8	6	8	6	8	6	8	6	8	16
2	16	12	16	12	16	12	16	12	16	12

	41 d.	49 d.	42 d.	48 d.	43 d.	47 d	44 d.	46 d.	45 d	45 d.
1	226	197	223	201	219	205	216	208	212	212
2	452	394	446	402	438	410	432	416	424	424
3	678	591	669	603	658	614	648	625	636	636
4	905	888	892	803	878	819	864	833	849	849
5	1132	984	1114	1003	1097	1023	1079	1042	1061	1061
6	1358	1181	1337	1204	1316	1228	1295	1250	1273	1273
7	1584	1378	1560	1406	1535	1433	1511	1458	1485	1485
8	1810	1575	1783	1607	1754	1638	1727	1666	1697	1697
9	2036	1772	2006	1807	1974	1842	1943	1874	1910	1910
10	2264	1968	2229	2007	2194	2046	2158	2084	2122	2122
1	8	7	7	7	7	7	7	7	7	7
2	16	14	14	14	14	14	14	14	14	14



	36 d.	54 d.	37 d	53 d.	38 d.	52 d.	39 d.	51 d.	40 d	50 d.
1	176	176	240	180	236	185	233	189	230	193
2	486	352	480	360	472	370	466	378	460	386
3	729	528	720	541	709	555	699	567	690	578
4	881	705	960	721	945	739	932	756	920	771
5	1213	881	1198	902	1182	923	1165	944	1149	964
6	1456	1057	1438	1082	1418	1108	1398	1133	1379	1157
7	1699	1234	1678	1262	1654	1293	1631	1322	1609	1350
8	1942	1410	1918	1443	1890	1479	1865	1511	1839	1543
9	2185	1586	2157	1624	2126	1663	2098	1700	2069	1735
10	2427	1763	2396	1805	2364	1847	2331	1888	2298	1928
1	8	6	8	6	8	6	8	6	8	16
2	16	12	16	12	16	12	16	12	16	12

	41 d.	49 d.	42 d.	48 d.	43 d.	47 d	44 d.	46 d.	45 d	45 d.
1	226	197	223	201	219	205	216	208	212	212
2	452	394	446	402	438	410	432	416	424	424
3	678	591	669	603	658	614	648	625	636	636
4	905	888	892	803	878	819	864	833	849	849
5	1132	984	1114	1003	1097	1023	1079	1042	1061	1061
6	1358	1181	1337	1204	1316	1228	1295	1250	1273	1273
7	1584	1378	1560	1406	1535	1433	1511	1458	1485	1485
8	1810	1575	1783	1607	1754	1638	1727	1666	1697	1697
9	2036	1772	2006	1807	1974	1842	1943	1874	1910	1910
10	2264	1968	2229	2007	2194	2046	2158	2084	2122	2122
1	8	7	7	7	7	7	7	7	7	7
2	16	14	14	14	14	14	14	14	14	14

The Structure of this Table is from this ground:

As *Radius* is in proportion to the Distance of two places measured in their Rumb, so is the Sine of the Complement of that Rumb, to the difference in latitude of these two places.

And so is the Sine of that Rumb, to the distance of the Meridians of those two Places. As, admit I measure South-Easterly 20 deg. 300 Poles, here then the Rumb upon which I measure, making with the Meridian an angle of 20 degrees, I say,

As *Radius* is in proportion	
to the distance measured 300 poles;	2.47712
So is sine Complement the Rumb, S E 20 deg.	9.97299
to the difference of latitude 281 $\frac{91}{100}$ *ferè*.	2.45011

Whereby it appears, that the distance of the Parallels of these two places is 281 $\frac{91}{100}$ Poles; or that the place whereto I measure, is more Southerly than the place from which I measured, by 281 $\frac{91}{100}$ Poles. Now for the distance of their Meridians, say,

As *Radius* is in proportion	
to the distance measured 300 poles;	2.47712
So is the sine of the Rumb S E 20 deg.	9.53405
to their distance in longitude 102 $\frac{606}{1000}$	2.01117

Ch	Poles
1	28.19
2	56.38
3	84.57
4	112.76
5	140.95
6	169.14
7	197.33
8	225.52
9	253.71
10	281.92

And thus I find the place whereto I measured is more Easterly than the place from which I measured by 102 $\frac{6}{10}$ poles, and somewhat more. And in like sort may be found all the other numbers expressed in this Table; but having thus found for every Degree to 45 Degrees two numbers, the rest may be deduced from them, as in this Example: 300 poles at three poles to the Chain, is an hundred Chains or ten Changes, finding that in ten Changes upon this Degree, the difference Southerly is 281 $\frac{91}{100}$ poles, it must for five Changes, which is just half so much, be

be almoſt 141, and for one Change, which is a tenth part $28\frac{4}{10}$ *feet*, and ſo for two Changes twice ſo much, that is $56\frac{8}{10}$ for three Changes thrice ſo much, that is, the ſum of the two former, namely, $84\frac{12}{10}$, and ſo by Addition only you may find the reſt, as in this Table, which I ſhall need to proſecute no further. And thus you may make it to the hundredth or thouſand parts of a Pole; but this for ordinary occaſions, for which it was at firſt intended, may ſuffice.

And according to this Example, it will be eaſie to frame the like Table for a Chain of any other ſize, or for any other meaſure which you uſe.

It may be objected, That howſoever this Rule holds true in plain Triangles, yet the Triangles here uſed are neither plain nor Spherical; for a plain Triangle is made of three right Lines, and a Spherical of three Arches of great Circles; but in this the three ſides are of three ſeveral kinds; namely, one ſide is an arch of the Meridian, and ſo of a great Circle, another an arch of a Parallel, and ſo of a leſſer Circle, the third ſide or *Hypothenuſal* being the Rumb, is no arch of a Circle, but a ſegment of an Heliſpherical line.

But I anſwer, That notwithſtanding this may be ſpeculatively conceived, and ſo demonſtrated to be no plain Triangle; yet in ſo ſmall Diſtances as theſe which here we uſe, there can be no ſenſible nor ſcarce any numerable difference. Yea, the diſtance between two parallels by the Rumb and Diſtance given (being the thing here chiefly aimed at) is very exactly found by this Rule, as before we have ſhewed, and as is more fully demonſtrated by Mr. *Wright*, in the 12 Chapter of his Book, *Of the Correction of Errors in Navigation:* Whence we may conclude, that the parts of the Meridian collected by this Table according to the Rumbs and Diſtances, as we have before ſhewed, do give the true meaſure of the ſegment of that Meridian intercepted, between the parallels of the two places propoſed.

CHAP. IV.

Of the difference of Longitude, Position and Distance of York *and* London: *And how the Maps of* England *may by this Experiment be reformed, especially in the Latitude of Places.*

WE come next to speak of the Easterly and Westerly distances gathered, as before is shewed by these Tables, and to find thereby the difference of Longitude, and of this we will give an Example in the foresaid Experiment; whereby we find that the distance in Longitude, or the East and West distance between *York* and *London* is neer 14000 Poles, *London* being so much more Easterly than *York*. And before we have found that in a degree of the Meridian, and consequently in a degree of the Equinoctial, there is neer 3709 $\frac{1}{10}$ Chains, at six Poles to the Chain, and this 14000 Poles converted into such Chains is 2333 $\frac{1}{3}$.

Which 2333 $\frac{1}{3}$ Chains (for finding the difference of Longitude) are not to be reckoned in the parallel of *York*, that being too much Northerly, neither in the parallel of *London*, being too much Southerly, but in a middle parallel between both, namely, about the Latitude of 52 degrees 45 minutes. Now to find what difference of Longitude is answerable to this 2333 $\frac{1}{3}$ Chains in the parallel of 52 degrees 45 minutes, say,

As *Radius* is in proportion

to Sine complement the Latitude *sc.* 52 deg. 45 min.	9.78197
So is the measure of a deg. in the Equinoctial 3709 $\frac{1}{10}$	3.56927
to the measure of a degree in that Parallel 2245 $\frac{1}{10}$	3.35124

And

And thus we find that in the Parallel, whoſe Latitude is 52 degrees 45 minutes, there are 2245 $\frac{1}{10}$ Chains anſwering to a Degree, whereby it appears that the difference of Longitude between *York* and *London*, is more than one degree, and to find how much more, ſay again by the Rule of Proportion

As the meaſure of a degree 2245 $\frac{1}{10}$ *Co. ar.*	6.64876
is to a degree in *Seconds*, 3600	3.55630
So is the meaſure given, 2333 $\frac{1}{3}$	3.36797
to the number of *Seconds*, 3741	3.57303

Which reduced, is 1 deg. 2 min. 21 ſeconds, and thus we find that *London* doth differ in Longitude from *York* 1 deg. 2 min. 21 Seconds, being ſo much more Eaſterly.

Thus having the difference of Latitude, as alſo the difference of Longitude between theſe two places, we may (according to the ſecond Problem of ſailing by *Mercators Chart*) find the Rumb from *London* to *York* to be 14 degrees 20 minutes from the North to the Weſtwards; that is, North by Weſt 3 degrees 5 minutes Weſterly, and the diſtance in that Rumb 9442 Chains. But their diſtance in the High-way, by reaſon of the crookedneſs and un-evenneſs of it, was more by about an eighth part.

And the like might be done for other intermediate Places between theſe, but affecting brevity we paſs that over, as not much pertinent to our preſent purpoſe; only expreſſing the Latitudes of ſome of the principal of them, as followeth.

	Latitudes.
As the Latitude of *York*, we find to be	53 deg. 58 min.
Doncaſter	53 deg. 32 min.
Newark upon *Trent*	53 deg. 5 min.
Grantham	52 deg. 54 min.
Stamford	52 deg. 38 min.
Huntington	52 deg. 19 min.
Royſton	52 deg. 3 min.
Ware	51 deg. 48 min.
London	51 deg. 30 min.

We

We further noted in this Experiment, that howſoever the number of miles between *Ware* and *London* are almoſt the ſame by eſtimation that they are by meaſure; yet all the way beſides from *York* to *Ware*, a meaſured mile conſiſting of 320 Poles is but three quarters of a mile, as the miles lie by eſtimation or common account; ſo that every where (for the moſt part) three miles by eſtimation make four meaſured miles: and a minute, or the ſixtieth part of a Degree, is almoſt in the middle between them both: So that look how much a meaſured mile is leſs than a minute, ſo much or ſomewhat more is a mile by eſtimation greater than a minute; for as there is contained in a Degree of meaſured miles 69 ½ and ſomewhat more, as we have before ſhewed, ſo of our common eſtimated miles, there are contained about 51 ½ in a Degree.

Upon theſe grounds the whole Map of this Kingdom might be much rectified, eſpecially in the Latitude of Places; for though we cannot hence determine certainly the Latitudes of any other places beſides thoſe which were in the way, or at leaſt in ſight as we came up (the principal of which we have before noted.) Yet we may neerly conjecture the Latitudes of moſt parts of *England*, by their Diſtances and Poſitions from theſe; but theſe things being beſides our ſcope and purpoſe in this place, we ſhall only compare the latitude of ſome principal places, probably gathered from this experiment, with the Latitudes of the ſame places, as they are ſet down by Mr. *Speed* in his *Geographical* Deſcriptions of *England*; that ſuch as pleaſe to examine both in any particulars, may know to which they may more ſafely lean.

Canter-

	Latit. by this Exper.		Latit. by *M.* Sp. map.			Latit. by this Exper.		Latit. by *M.* Sp. map.	
	D.	M.	D.	M.		D.	M.	D.	M.
Canterbury	51	17	51	29	*Northampton*	52	14	52	36
Chichester	50	48	50	51	*Huntington*	52	19	52	44
Guilford	51	12	51	22	*Stamford*	52	38	53	04
Winchester	51	03	51	11	*Leicester*	52	40	53	06
Dorchester	50	40	50	44	*Lincoln*	53	14	53	50
Exceter	50	43	50	48	*Newark* upon *Trent*	53	05	53	38
Wells	51	13	51	22	*Nottingham*	53	00	53	32
Salisbury	51	04	51	12	*Darby*	52	58	53	30
Reading	51	28	51	42	*Stafford*	52	52	53	22
London	51	30	51	45	*Shrewsbury*	52	47	53	16
Colchester	51	58	52	36	*Chester*	53	16	53	52
Ipswich	52	08	52	30	*Lancaster*	54	10	54	57
Norwich	52	42	53	10	*York*	53	58	54	44
Cambridge	52	12	52	32	*Richmond* in *York-shire*	54	28	55	18
Hertford	51	49	52	06	*Kingston* upon *Hull*	53	48	54	29
Bedford	52	08	52	30	*Doncaster*	53	32	54	12
Buckingham	52	00	52	20	*Durham*	54	50	55	45
Royston	52	04	52	24	*Carlile*	55	00	55	56
Oxford	51	46	52	02	*Newcastle*	55	03	56	01
Glouceſter	51	53	52	12	*Barwick*	55	54	57	03
Hereford	52	07	52	27					
Worceſter	52	14	52	36					
Warwick	52	20	52	45					

The Latitudes of theſe Places in the firſt Column expreſſed are ſuch as are probably gathered from this Experiment. But in

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in the second Column, there is set down the Latitudes of the same places, as they are expressed by Mr. *John Speed* in his Map of *England*, set forth in his Book, entituled, *The Theatre of the Empire of Great Britain*; and lest there should be any mistake in his Map, I have conferred these Latitudes thence gathered with the Latitudes of the same Places set down by him in words at large, in his descriptions of each several County, and find them neerly to agree, except in the Latitude of *Barwick*, which in his Map he makes to be 57 degrees 3 minutes; but in his Historical Descriptions of *Northumberland*, he relates it to be 55 degrees 48 minutes, which last is much neerer the truth, but seems not to be his meaning; because then he should make it more Southerly than *Newcastle*, yea more Southerly than he doth *Carlile*, which by his Map, and also by his words in his Relation of *Cumberland* is in the Latitude of 55 degrees 56 minutes; whereas *Barwick* is above 50 miles more Northerly.

By these you may neerly conjecture the Latitudes of other parts of *England*, lying in or neer the same Parallel with any of them: And hence also it appears, that the difference of Latitude between *Barwick* and the South Coast of *England* neer *Christ-Church*, is little more than 5 degrees, not 6 degrees and more, as some of our Maps make it. But these things we must leave, that we may proceed to that which is principally intended, only we will first touch a little upon the use of the fore-going Table in Plotting and Surveying of Land.

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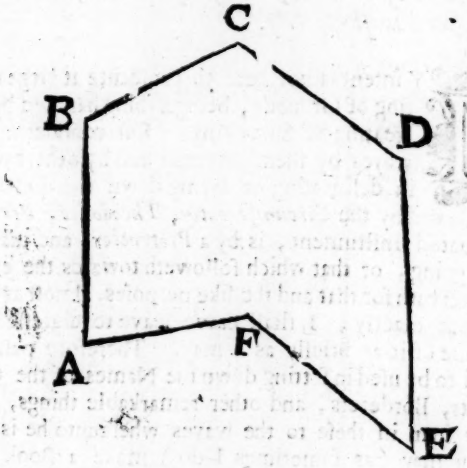
CHAP. V.

To Delineate the Plot of any Forreſt, Park, Common, or other pieces of Ground; as alſo of Rivers, Harbours, &c. ſpeedily and moſt exactly.

MY intent is not here to proſecute at large the Plotting of Grounds, being a thing handled by others, treating of Surveying: But conſidering that the wayes by them directed and by others practiſed, in delineating or laying down the Diſtances and Angles obſerved by the *Circumferentor*, *Theodolite*, *Peractor*, or other graduated Inſtrument, is by a *Protractor*, and that the Table before going, or that which followeth towards the end of this Treatiſe, ſerveth for that and the like purpoſes, almoſt as ſpeedily, and far more exactly, I ſhall crave leave to digreſſe a little to ſhew this uſe of it as briefly as I may. Therefore paſſing over the method to be uſed in ſetting down the Names of the Grounds, the Tenants, Borderers, and other remarkable things, and leaving every man in theſe to the wayes whereunto he is accuſtomed. You may (as ſometimes I do) make a Book in a long *Octavo*, and upon the left ſide thereof ſet down ſuch things, as theſe before mentioned, reſerving every right ſide, and dividing them by Ruled Lines into ſix Columns; as hereafter following appeareth.

And having taken and ſet down your Notes in the Field on the left ſides or pages of your book, you may in the evening or next morning before you go out, or when elſe your occaſions will permit, ſet down in the firſt Columns on the right ſide, how many Degrees the Lines upon which you have traverſed, are diſtant from the North or South-part of the Meridian towards the Eaſt or Weſt; and in the ſecond Columns the quantity of the ſame Lines, in Changes, Chains, and ſingle Poles, and parts of Poles.

As in this Figure, suppose the Line from A to B to be directly East seven Changes, that is, seven times 30 Poles, or 210 poles, from B to C to the Eastwards of the South 35 degrees, 8 Changes, and one Chain, from C to D, to the Westwards of the South 32 degrees, five Changes, and four Chains, from D to E



to the Westwards of the South 80 degrees, ten Changes, from E to F, to the Eastwards of the North 35 deg. six Changes, three Chains, and two thirds of a Pole. And lastly, from F to A, the place where I first began, to the Westwards of the North 9 deg. 5 Changes, 3 Chains, $2\frac{1}{3}$ poles: All these I expresse in the first and second columns on the right side, as hereafter following appeareth.

Which done, I take the Table, and find there the Northing and Southing, Easting or Westing answerable to these Degrees and Distances, and set them down accordingly. As for the first being East seven Changes, I set down in the East column 210 Poles

Poles with a Cipher behind it. For the second being *SE*, 35 deg. I find in the Table for 5 Chains 1228, to be set in the South Column, and 860 for the East Column: also upon the same degree for 1 Chain 25 for the South Column, and 17 for the East Column; and so I proceed with all the rest, untill I have finished.

Deg.	*Dist.*	*North.*	*South.*	*East.*	*West.*
East.				2100	
SE 35			1228	0860	
			0025	0017	
SW 32			1272		
			0102		0795
SW 80			0521		0064
					2954
NE 35		1474			
		0074			
		0005		1032	
				0052	
		1481		0004	
NW 09		0089			0234
		0025			0014
					0004
		3148	3148	4065	4065

And being thus returned to my first Station, I summe up severally these four Columns of North, South, East and West; and finding that the summe of the North column is equal to that of the South, and the summe of the East is equall to that of the West, I conclude the whole Work to be truly performed, whereas if there had been any difference, it had shewed an Errour; and if that difference had been great, it had been necessary to examine the Work again, and so to correct it.

It is usual to add together all the angles, and also to multiply two right angles, or 180 degrees by the number of angles lacking two; and if the summe of the angles added together be equal to this Product, the Work is thought to be true: as here, if we add the inclinations and reclinations of these Lines in this Figure, the sum is 720 deg. or eight right angles, and if we multiply two right angles by 4, (because here are six angles) the Product is also eight right angles. But the other by the summes of the Columns, is a most absolute way for examining the truth of your work, and to be preferred before any other that I know.

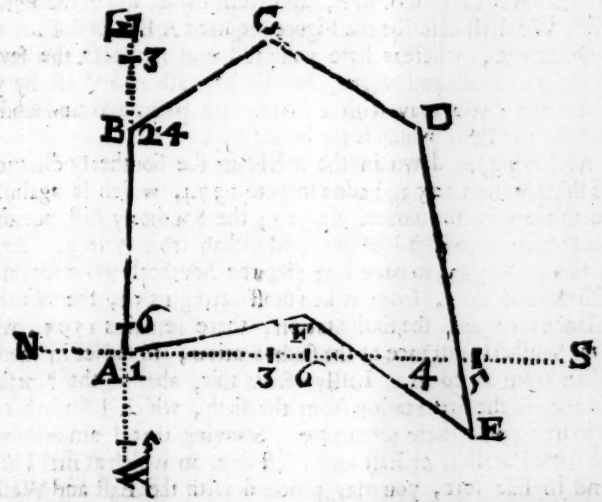
It may seem very laborious to set down every Station in this manner, but one that is a little exercised in it may; as I take it (for I never observed the time exactly) set down 40 or 50 Stations in this manner, within the space of an hour, or thereabouts; but I should advise that it be done by two men, having each a Table for that purpose to avoid all mistakings.

If your Instrument give not the angle with the meridian expressly, yet it may easily be gathered thence, or else you may divide a Circle as your Instrument is divided, and number the Degrees as they are there numbred; which done, number them also from the North and South part of the Meridian towards the East and West, so shall you easily know the angle of any Degree with the meridian.

Now to proceed, these measures may be set down in a Plot several wayes. As first, considering which way the Ground lies, I take a point for my first Station, so as the whole may fall conveniently within the plot, which let be the point A, by which point I draw a Meridian and Parallel, namely two right lines intersecting one another at right angles: whereof let *N S* be the meridian running North and South, and *E W* the parallel running East and West; this done, I look to the North and South Columns, and there first in the South Column, and against the third Station, I find 1253, that is, $125\frac{3}{10}$ Poles, this I set in the meridian from A to the Southwards, and mark the point with the figure 3, then in the South Column against the fourth Station, I find 1374, which I set in the Meridian from 3 to 4:

also

alſo againſt the firſt Station I find 521, which I ſet in the Meridian from 4 to 5. Then againſt the Sixth Station, I find in the North column 1553, which I ſet in the meridian from 5 to 6: alſo againſt the ſeventh Station, which is the ſame with the firſt, I find 1595, which I ſet in the meridian from 6, and it falls upon A, which is the firſt Station: and thus I have done with the South and North columns.



In like ſort I expreſſe the meaſures in the Eaſt and Weſt Columns in the Parallel E W. As finding firſt in the Eaſt Column 2100, I ſet it down from A to the Eaſtwards, and it extends to B, where I ſet 2, ſignifying my ſecond Station; I find next in the Eaſt Column 877, which I ſet in that Parallel from 2 to 3, next in the Weſt Column 859, which I ſet in that Parallel from 3 to 4: and ſo I proceed with the reſt. And having thus ſet down the meaſures in the meridian and parallel, we have alſo as it falls out in this Example two Stations expreſs'd, namely A and B, now

now for the third; I take in the Parallel with my Compaſſes the diſtance A 3, and ſetting one foot in the meridian at 3, I ſtrike an arch neer C; alſo taking in the meridian the diſtance A 3, and and fixing one foot in the parallel at 3, I croſſe the aforeſaid arch neer C, the interſection of theſe two arches is the point C, repreſenting the third Station.

In like ſort, I proceed to find the points D E F for the fourth, fifth, and ſixth Stations; then drawing Lines, namely from the firſt Station A to the ſecond B, and from the ſecond to the third C, *&c.* We ſhall deſcribe the Figure required A B C D E F.

Otherwiſe, whereas here you add and ſubſtract the ſeveral diſtances of South and North, as alſo of Eaſt and Weſt by your Compaſſes; you may with a little more pains add and ſubſtract them by the Pen, which is the better way.

As having ſet down in the meridian the Southerly diſtance of the third Station 1253, I adde thereto 1374, which is againſt the fourth Station, the ſumme is 2627; the Southerly diſtance of the fourth Station, which I ſet in the Meridian from A to 4. Again, to this I add 521, ſo have I 3148, the Southerly diſtance of the fifth Station A 5, from which ſubſtracting 1553, the Northerly diſtance ſet againſt the ſixth Station, there remains 1595, which is the Southerly diſtance of the ſixth Station, to be ſet in the meridian from A to ſix. Laſtly, from this, abating the Northerly diſtance of the firſt Station from the ſixth, which I find there alſo to be 1595, there remains 0. Shewing that I am returned to the ſame Parallel, or Eaſt and Weſt line, in which at firſt I began. And in like ſort, you may proceed with the Eaſt and Weſt columns, and then by the interſection of two arches, find every Station, as before.

Other wayes might be preſcribed, which will not be hard to find of your ſelf. And as we may thus lay down any irregular right-lined Figure far more exactly than by the *Protractor*: So when it is laid down after this manner, we may caſt up the *Area*, or Superficial quantity of it very exquiſitely: Yea, if there ſhould be a Plot drawn (according to the Angles and Diſtances here given) after the uſual manner by a Scale

Scale ſo large, that the Plot ſhould be an hundred times ſo great as this; Yet could not the content thereof be caſt up ſo exactly and certainly as it may be here.

But I muſt not inſiſt upon theſe things, they may of themſelves be conceived, and mine intent is only to touch them, that I be not prevented of time, and by other occaſions from handling thoſe things which I have here more ſpecially intended.

But as I have ſaid, this courſe is chiefly to be uſed in plotting large grounds, and there indeed are graduated Inſtruments, eſpecially to be uſed: for other ſmaller grounds, there is none more fit then the *Plain Table.*

CHAP. VI.

Of the Compaſſe of the Earth, and the quantity of a Degree, according to the moſt approved Experiments Ancient and Modern.

ALthough the Compaſſe of the Earth hath been in ſome ſort obſerved by divers of the Ancients: Yet for ſome of them we cannot certainly gather what meaſures they uſed; others uſed no meaſure at all, but aſſumed the Diſtance of Places to be ſuch as it was eſtimated by Travellers to be, and likewiſe the Latitude; therefore it will be needleſſe to inſiſt upon the examination of their Obſervations, others of them which were taken by meaſure, and which we may upon any good ground reduce to our meaſures, are theſe which follow.

Willebrordus Snellius in his Book entituled *Eratoſthenes Batavus*, cites *Abel Hedas*, a moſt diligent *Arabian*-Geographer, that lived about the year of Chriſt 1322, who records, that about

about the year of Christ 827, certain men skilful in the *Mathematicks*, did by the commandement of their Prince *Almanon*, measure in the fields of *Mesopotamia* (as he gathers) under one and the same meridian, from the North towards the South, the quantity of a degree, and found it to be 56 miles, or somewhat more. The quantity of their mile, according to *Alphraganus*, was 4000 Cubits, or 6000 Feet, whence the quantity of a degree should be 336000 Feet; but of the length of their Feet we are something uncertain, only they define it to be so long as the extent of 96 barley corns laid side by side; whereas the *Rhynland*-foot, according to tryal by him made, is but the extent of 90 corns laid in like manner, so that if there be no inequality in the grains, then 90 *Arabian*-feet are equal to 96 *Rhynland*-feet. But 96 *Rhynland*-feet are found to be about $91\frac{1}{4}$ *English*-feet, therefore also, by the Rule of Proportion, 336000 *Arabian* feet do make of our *English*-feet 370222. So that according to this experiment of the *Arabians*, a Degree should contain 370222 of our *English*-feet. And before we have found by the Observations taken at *London* and *York*, and by the distance of their parallels measured, that a Degree contains of our *English*-feet 367200. The difference is only 3022 feet, that is about the $\frac{1}{120}$ part of a Degree or half a minute.

He cites next *Alhazen* the *Arabian*, who in his Book *de Crepusculis*, declares the compasse of the Earth to be 24000000 Paces, so that proportionally there must be in one degree $66666\frac{2}{3}$ paces, that is 333333 *Arabian* feet. And seeing that 90 *Arabian* feet make of our *English*-feet $99\frac{1}{6}$, therefore by the Rule of Proportion 333333 *Arabian*-feet, make of our *English*-feet 367283: So that according to *Alhazen*, there should be in a Degree 367283 of our *English*-feet differing from the Experiment which I made only 83 feet in a Degree.

I have not strained these numbers to bring them to this neerness, they are the same in effect which are set down by *Snellius* in his *Eratosthenes Batavus*, who with great industry and judgment hath compared the measures of the Ancients, and the measures used by several Nations in these times, with the *Rhyn-*

Rhyniand-foot. Much leſs have I ſtrained mine own numbers to draw them up to theſe: But on the contrary, I confeſs upon the ſight of his Book, obſerving the great pains and induſtry which he profeſſeth himſelf to have beſtowed, and which I doubt not but he did imploy in making his Experiment, and how he had found the meaſure of a degree to be much leſs than mine, as we ſhall after ſhew, I began to doubt that I had not made ſufficient allowance for the un-evenneſs of the ways, and for ſome ſmall bendings, ſometimes to the right hand, ſometimes to the left, the obſervation whereof I wittingly neglected, to ſpare time and Expence. For I did often obſerve a mile or two before me, ſome Mark in the High-way noting the degree, and meaſuring to it in the way, neglecting to obſerve the intermediate ſwervings of the way, ſometimes three or four degrees towards the right hand, ſometimes as much to the left, but making ſuch allowance for that, and for the un-evenneſs as I judged ſufficient. And ſome men may think, that the exact Obſervation of theſe leſſer things thus neglected, and regulated only by judgment or conjecture, might deceive me much: But they may conſider, that if there be two places a mile diſtant, that is, in a right line 320 Poles, if you meaſure from one of theſe places towards the other, not in that right line, but alwayes ſwerving from it by an angle of four degrees, ſometimes to the right hand, ſometimes to the left, till you come to that other place; I ſay, that notwithſtanding all theſe ſwervings (if there be nothing elſe to augment the meaſure) it will not amount to 321. Now conſidering that I had all the way, as occaſion required, made ſuch allowance as ſeemed convenient, and ſo found 367200 Feet in a degree, before I compared it with the meaſures taken by an other: I reſolved not to diminiſh nor to augment the number thus ariſing by my Obſervations, Meaſures, and Allowances, in reſpect of the Opinions, Obſervations, or Meaſures of any other man, until there be made ſome Experiment more evident and exact than any yet extant. And I am ſomething the more confirmed by the neer agreement of theſe two teſtimonies before recited, both exceeding me a little in the meaſure of a degree. But we cannot con-

fidently rest upon them, because of that inequality which may be of Corns or Grains; for theirs may haply be something greater or lesser than ours.

Both these measures of a Degree do much exceed the quantity of a Degree found by *Snellius*, but when he compares them with his own another way, namely, placing the Barley-corns so that they may not lie flat, but be set up edge-wise, and so by 96 Corns to make a Foot, and by such Feet to measure a Degree; then he finds that the quantity of a Degree, according to the *Arabians*, is much less than by his Experiment it should be: but if some be laid flat, and others set up edge-wise, the *Arabian* measure of a Degree will agree with his. And so he proposeth this doubt, whether the 96 grains, whereof the *Arabian* foot doth consist, must lie flat or be set up edge-wise, or some of them to lie flat, and others to be set up edge-wise. But it is most probable that they must lie flat, that being the position which they are apt unto by nature; they cannot be set edge-wise without much trouble, especially so many together as make the length of a foot, and so the *Arabian* measure of a degree doth neerly agree to this of mine.

We come next to hear the determination of *Ptolomy* of *Alexandria*, whose authority and credit in the solution of this question is not inferiour to any of the Ancients. He affirms the Compass of the Earth to be 180000 *Stadiums*, and the quantity of a degree 500 *Stadiums*; the same (as *Strabo* saith in his 2 Book of *Geography*) was before affirmed by *Posidonius*. Also *Marinus Tyrius* (before *Ptolomy*) had determined the quantity of a Degree to be 500 *Stadiums*. *Ptolomy* confirms it, not simply from their relations, but as it seems from his own experience, and that by some measures diligently taken, for in the 11 Chapter of the first Book of his Geography, he hath these words; *Sed in hoc quoque recte sentit, partem unam qualium est circulus maximus trecentorum sexaginta; quingenta in terra constituere Stadia, id enim confessis dimensionibus consonum existit.* Also *lib.* 7. *cap.* 5. *Itaut pars una, seu gradus unus quingenta contineat Stadia, quemadmodum ex diligentibus deprehen-*

sum

sum est dimensionibus. Now a *Stadium* not only amongst the *Greeks*, but as appears by *Herodotus* amongst all other Nations of *Asia* and in *Egypt*, did consist of 600 feet: therefore a Degree according to *Ptolomy*, must contain 300000 feet. But the *Egyptian* or *Alexandrian*-foot was much greater than our foot; for as we have before said, the ancient *Roman* foot is greater than ours, and the *Egyptian*-foot was much greater than the *Roman:* For it is often testified by *Hero Merchanicus*, that five *Alexandrian*-feet make six *Roman*-feet. And Mr. *Snellius* hath very ingeniously gathered both from *Philandes* and otherwise, that the *Rhynland*-foot is equal to the ancient *Roman*-foot; therefore also five *Alexandrian*-feet are equal to six *Rhynland*-feet: So that by the rule of proportion, 300000 *Alexandrian*-feet will make of *Rhynland*-feet 360000. But by the size of our *English*-foot, which was sent him from the Iron Standard in *Guild-hall*, he finds it to contain but 968 such parts as the *Rhynland* contains 1000: So that 968 *Rhynland* feet are equal to 1000 *English*, or 121 *Rhynland*-feet are equal to 125 *English*-feet. Therefore also by the Rule of proportion, 360000 *Rhynland*-feet are equal to 371900 of our *English*-feet. Therefore according to *Ptolomy*, there are contained in a Degree 371900 of our *English* feet. But by our fore-mentioned Experiment made between *York* and *London*, we find only 367200 feet in a degree, being less than *Ptolomies* by 4700 feet, that is, by $\frac{1}{78}$ part of a Degree, or $\frac{1}{4}$ of a Minute, and little more.

Fernelius a modern Author and learned Physician, measuring the way by Revolutions of a Wheel, and the Latitudes by Observation, finds in a Degree 68 *Italian* miles, and 96 Paces, the Pace which he used being more than five of our *English*-feet: But because he handled not the Problem exactly, and is suspected by *Snellius* (though I think without cause) to have grounded his Conclusion rather upon the Experiment of the *Arabians* before set down (wherewith it doth nearly agree) than upon his own, we will insist no longer upon it.

We come in the last place to the Experiment of *Willebrordus Snellius*, a *Hollander*, made in the *Netherlands* about 20 years past.

paſt. We ſhall not need to recite the particulars of it, being extant at large in his book before mentioned, but in Concluſion he finds in a Degree 342000 *Rhynland*-feet. Now a *Rhynland*-foot (as he hath there ſhewed, comparing both together) is greater than ours, and that in ſuch proportion, as 1000 is to 968, (and ſo much or little more it appears to be by that Model of the *Rhynland* foot Printed in his Book) therefore 968 *Rhynland*-feet muſt make 1000 of ours; and hence by the rule of Proportion, 342000 *Rhynland*-feet, will make of our *Engliſh*-feet 353306. So that there ſhould be in a Degree only 353306 feet, which is leſs than we have before found in a Degree, by 13894 feet, that is, by $\frac{1}{10}$ part of a Degree, or $2\frac{1}{4}$ Minutes, and ſomething more. He was a man doubtleſs of ſingular induſtry and knowledge, and of much exerciſe in the Mathematicks, and it may be, was well experienced in this particular, touching the Geometrical menſuration of diſtances, and he hath beſtowed much pains and diligence in this Experiment, as by his book appeareth. But if he had by a Chain meaſured the Diſtance of his two utmoſt Stations (if the ground would permit, which I ſuppoſe it would not) or at leaſt-wiſe if his meaſured Stations had been further diſtant: I conceive he would have found a greater Diſtance in his two utmoſt places of Obſervation. But if a man, intending to find the Diſtance of two places, meaſure only the $\frac{1}{100}$ part of that Diſtance, and by that meaſured Line and the angles, think to find their true Diſtance; whether he do it immediately from thoſe two meaſured Stations, or mediately by help of others obſerved from them, he may eaſily fall into ſome notable Error. For though the Problem be exactly true in Geometrical Demonſtrations, how ſmall ſoever the meaſure be, yet it is not ſo in ſenſible and experimental practices, by reaſon of the weakneſs even of the beſt eye, and the imperfection of the Inſtruments in themſelves, and in their uſe. And beſides that, there were many Stations obliquely ſituate; A man cannot always hit the juſt middle of that Turret, Steeple, or other mark which he obſerves: Neither when he comes to make his Station there, can he always place his Inſtrument juſt at the concourſe of his former

mer visual Lines, by reason of other impediments. Besides the force of the wind in such eminent places: add moreover that amongst so many Steeples as there are in some Towns, there, a man may at some time mistake one for another. And if there should happen no notable Error, by reason of any or of all these Casualities: Yet may two Minutes in the difference of the Latitude of two places be easily mistaken, especially being derived from the Latitudes of those places which are very rarely set down true to a minute.

If it be objected, that I might aswel be so much mistaken in the difference of the Latitudes of *York* and *London*.

I answer, it is not so likely, because I had the opportunity of observing the Summer Soltitial Altitude of the Sun in both places, wherein I had no necessary use of the Suns Parallax nor Refraction, nor of the Table of the Suns Declination, any of which may cause more than a minutes error, in finding the Latitude of either place.

Besides, if mine Error in those Observations should be full as much, yet would it not in the Conclusion be half so much, because the difference in Latitude of the two places of mine Observation is more than twice so much as that of his.

But let this suffice, leaving every man to embrace that which he shall best approve. Both our experiments do sufficiently convince that common error of counting only 300000 *English*-feet to a Degree, besides the consent of other Observations before recited ancient and modern.

Mr. *Snellius* hath further in that book of his, entituled *Eratosthenes Batavus*, with much diligence compared some ancient measure, as also the measures of sundry Forreign-Countreys with the *Rhynland*-foot, and amongst the rest, our *English* foot, according to a size thereof to him sent from the Standard in *Guild-Hall*, (from whence also I had about twenty years past the size of that Foot which I have used in this measure) we shall not need to repeat them all, because his Book is extant: some of them are these following, which we here compared to our *English*-foot, as he hath there done to the *Rhynland*, that so any of them

them may the more eaſily be reduced into our Feet. Therefore dividing the *Engliſh*-foot into 1000 equal parts, we ſhew how many of thoſe parts are contained in other ancient and forreign feet.

Ancient feet compared with our *Engliſh*-foot.

Of ſuch parts as the *Engliſh*-foot contains		1000
The	Ancient *Roman*-foot contained	1033
	Ancient *Greek*-foot contains	1076
	Babylonian contains	1211
	Alexandrian contains	1240
	Antiochean contains	1405
	Arabian contains	1102

Forreign feet compared with our *Engliſh*.

Of ſuch parts as the *Engliſh*-foot contains		1000
The	*Rhynland*-foot contains	1033
	Dort-foot contains	1085
	Middleburgh-foot contains	992
	Amſterdam-foot contains	934
	Antwerp-foot contains	939
	Lovain-foot contains	939
	Hafnian-foot in *Denmark*	965
	Paris-foot called the *Kings*-foot	1090
	Venice-foot	1157
	Toledo foot	896
	Nuriberg-foot	1006
	Stratsbourg-foot	920

CHAP. VII.

Of dividing the Log-line, and reckoning the Ships way.

THERE be four things, upon which the Practice of Navigation is eſpecially grounded; namely, the knowledge of the Longitude, Latitude, Courſe, and Diſtance. Touching the Longitude, though it may be found by the other three, yet hitherto there hath not been delivered any general Rule true and practicable, whereby the Longitudes

gitudes of places might be immediately and ordinarily found of themſelves. The Latitudes of places may immediately be found by Obſervation of the Sun and Stars, as we have formerly ſhewed in the Appendix to the Doctrine of Triangles.: The Courſe by the Compaſs, the Variation being duely obſerved, wherein we have many good Mariners very expert, this we have alſo handled in the Doctrine of Spherical Triangles. The diſtance run is found of it ſelf by the *Log-line*, whereof we are here to ſpeak.

The ground of finding the diſtance run by the *Log-line* is meerly conjectural, being founded upon this opinion, that five of our feet make a pace, and a thouſand ſuch paces make a mile, and that 60 ſuch miles make a Degree; ſo that a Degree ſhould contain 300000 of our feet: But it appears not only by this Experiment, but even by all others that were diligently taken, and their meaſures to us known, that there is a greater number of our feet contained in a Degree.

There be three things (as I conceive) that have cauſed this error to be ſo commonly received and tollerated. The one, for that it doth ſomewhat counterpoiſe another contrary error in the Practice of *Navigation*: namely, in the uſe of the *Plain Chart*; for the error which is there committed by making every parallel equal to the Equinoctial, and ſo every Degree in them greater than they ſhould be, is ſomething moderated by this error; whereby the meaſure of a Degree is eſteemed leſs than indeed it is.

For inſtance; It is evident by the *Globe*, that the Meridians concurring in the Poles grow neerer and neerer together, as they grow towards the Poles; Inſomuch, as if two Meridians be diſtant in the Equinoctial ten Degrees, that is, 600 Miles, the ſame Meridians in the Latitude of 35 Degrees, will be diſtant little more than 490 Miles. Now if unto every Mile we account according to the former Experiment 6120 feet, then is the diſtance of thoſe two Meridians in that parallel neer 3000000 feet. In like ſort in the *Plain Chart* ten Degrees of that parallel (as of all others) is made equal to ten Degrees of the Equinoctial or Meridian:

ſo

ſo that the diſtance of theſe two Meridians will upon the *Plain-Chart* be 600 miles, but one of theſe miles contains only 5000 feet, ſo that the diſtance is but 3000000 feet, equal to the former.

And although theſe errors in other caſes do not juſtly ballance one another as in this Example, yet that of the *Plain-Chart* is always ſomething moderated by this other, and ſo much the more by how much they are neerer to the foreſaid Latitude. I grant that this is only ſo, when the courſe is neer unto the Eaſt or Weſt points; but withal, I ſay that this kind of reckoning is (in a manner) then only uſed: For he that runs any courſe neer the Meridian Southerly or Northerly, hath a more certain way of reckoning; namely, his Latitude, which he finds daily by Obſervation of the Sun and Stars, upon which he will depend, either neglecting or at leaſt not regarding his dead reckoning. Yea, (if it may be) never caſting the *Log* ſo much as once in ſuch a Voyage, having a more ſure ground for his reckoning. But in a Courſe that is neer the Eaſt and Weſt (foraſmuch as there is no way diſcovered for finding the Longitude) he is driven of neceſſity to make uſe of his dead reckoning.

We might add moreover, that the principal Voyages of this kind, I mean of thoſe which conſiſt of Courſes much Eaſterly and Weſterly, as to and from the *Weſt-Indies*, and the Parallel of *Cape bon Eſperance* are neer unto this Latitude of 35 degrees; ſo that as ſome of them are more Southerly, others of them are more Northerly.

But to inſiſt no longer upon this, I ſuppoſe a ſecond cauſe to be, for that men commonly deſire to have their reckoning before their Ship (as they ſay) that they fall not with a place before they look for it; And this comes ſo to paſs, whileſt the miles are accounted leſs in meaſure, and ſo more in number than they are indeed.

And thus, though there may ſeem to be ſome commodity in theſe errors, eſpecially when they do neerly ballance one another: Yet becauſe they ſeldom do ſo, but always leave men in uncertainties, and oftentimes in great perplexity and danger, it

it is much safer and better to reject them both, and to imbrace those wayes, which are evidently grounded upon truth, though there may be in them some more difficulty at the first. Yet I confesse, that he which reforms one and not another, may sometimes erre so much the more thereby. And I doubt not, but many would reform them both, if they could certainly do so.

Therefore a third cause of admitting and retaining this Errour seems to be, for that there hath been no way delivered from evident and certain grounds for the rectifying of it. I doubt not but many have found Errors in their reckonings arising from hence, that they account only 300000 of our feet to a Degree; but not knowing certainly where to lay the fault, have imputed it sometimes to ill steerage, otherwhiles to the Variation of the Needle, or to some mistake in their Reckonings, or to some error in their Plots, or to some Current, or such other accident, and so the Error hath rested unreformed. Wherefore although the practical performance of this Problem for finding the Circumference of the Earth, or the quantity of a Degree on the same, have many singular uses which I cannot now touch; yet that which amongst the rest I chiefly aimed at, was, that we might have a more sure and evident ground for dividing the *Log-line*, and for reckoning the ships way or distance run more truly upon any Rumbe or point of the Compasse than formerly.

And now to apply it to this purpose, we have noted before (*Chap.* 2.) that by the Experiment there expressed, we find in a Degree on the circumference of Earth and Sea, 367200 of our *English*-feet. Wherefore retaining still the same division of a Degree into 60 miles or 20 leagues (as hath been formerly used) a Mile will contain 6120 feet, or 1020 fathoms: And so a League contains 18360 feet, or 3060 fathoms; for dividing 367200 by 60, the quotient is 6120, *&c.* Thus then 60 miles being a Degree, every mile is 6120 feet.

Now supposing the time of the running out of the *Log-line* to be measured by an half-minute glasse, if we observe how many feet or fathom she runs in half a minute; we may thereby find her way for an hour or four hours, or for any other time proposed.

As admit there runs out of the *Log-line* in half a minutes ſpace 51 Feet, or 8½ Fathoms, and you would know what way the ſhip makes every hour after the ſame rate;

Say by the Rule of Proportion;

If 0½ Minute, give 51 Feet,

What gives 60 Minutes? Or,

If 1 Minute give 102 Feet:

What gives 60 Minutes?

And ſo multiplying, you ſhall find 6120 Feet, which is one mile. Or, if you would find her way for four hours, which is 240 minutes; Say,

As 1 minute, is in proportion to 240 minutes,

So are 102 Feet, to 24480 feet, or 4 miles.

Or if you would have it in fathoms; ſay,

As 1 minute, is in proportion to 240 minutes;

So is 17 Fathoms, to 4080 fathoms, the ſhips way in four hours. The like is to be conceived, if your Glaſſe be for any other quantity of time above or under half a minute.

Some have thought that the way which the ſhip maketh, may be known to an old Sea-man by experience (as they ſay) that is, by conjecture: Which opinion makes ſome neglect the uſe of the *Log*, leſt they ſhould be accounted young Sea-men. But as he that rides often will have ſome neer gueſſe how farre the Pace he rides will carry him in an hour (becauſe he hath often obſerved it formerly) ſo he which hath often ſailed and kept an account of the ſhips way by the *Log*, will be able to give ſome neer eſtimate of her way without the *Log*. But it is incident to ſome men to have ſuch a conceit of this their eſtimate, that they think it more certain than the Rule it ſelf, from whence it is derived, eſpecially if it chance to anſwer their expectations at ſome times.

It is thought alſo that the ſhips way may be known by two marks on the ſhips ſide, but this is doubtleſſe very uncertain, both by reaſon of the ſhortneſſe of the time, and in reſpect of the dead water (as they call it) by the ſhips ſide. For the water which is neer the ſhip, is drawn along with the ſhip in her motion,

motion, and ſo much the more, by how much it is neerer.

But if any deſire to make tryal of this way, it is to be conſidered, that 17 foot is $\frac{1}{100}$ part of a mile, and 10 *ſec.* of a minute is $\frac{1}{100}$ part of an hour: therefore if there be two marks on the ſhips ſide diſtant 17 feet, if the ſhip run the diſtance of theſe two marks in 10 *ſeconds*, ſhe runs a mile an hour, if in 5 *ſeconds* two miles an hour, if ſhe runs that diſtance in 2 *ſeconds*, ſhe runs 5 miles an hour. And ſo alwayes dividing 10 *ſeconds* by the number of *ſeconds*, in which the ſhip runs that diſtance, the quotient ſhews the miles and parts of a mile run in an hour.

But if the Diſtance of thoſe two marks be 34 feet, if ſhe run it in 20 *ſeconds*, it is after a mile an hour, if in 10 *ſeconds*, two miles an hour, if in 5 *ſeconds* four miles an hour: And ſo alwayes dividing 20 *ſec.* by the number of *ſeconds*, in which the ſhip runs that diſtance, the quotient ſhews how many miles the ſhip runs in an hour. As if the ſhip run that diſtance of 34 feet in 8 *ſeconds*, then dividing 20 by 8, the quotient is $2\frac{1}{2}$, ſhewing that ſhe runs $2\frac{1}{2}$ miles in an hour. Or, if you can conveniently make the diſtance of the two marks on the ſhips ſide to be 51 feet (for the further they are diſtant, the better) then if the ſhip run that diſtance in 30 *ſec.* it is a mile an hour, if in 10 *ſec.* it is 3 miles an hour, and ſo alwayes dividing 30 *ſec.* by the number of *ſeconds*, in which the ſhip is running that diſtance, the quotient ſhews after that rate how many miles the ſhip runs in an hour.

Otherwiſe you may do thus, divide 17 feet into 10 parts, and ſet as many of thoſe parts on the ſhips ſide, as conveniently you may, (which according to the ſhips length will be more or fewer.) Then when the ſhip runs one of thoſe parts in a *ſecond* of time, it is a mile an hour: when two, it is two miles an hour; when 5, it is 5 miles an hour. And in general, if you divide the number of parts run by the time of running accounted in *ſeconds*, the quotient ſhews what number of miles after that rate are run in an hour.

As if ſhe run 30 of thoſe parts in 5 *ſeconds*, it is 6 miles an hour; for dividing thirty by five, the quotient is ſix; ſo if ſhe runne 42 of thoſe parts in ten *ſeconds*, dividing 42

by 10, the quotient is 4 $\frac{2}{10}$, which ſheweth the ſhips way at that time to be after the rate of four miles and two tenths of a mile in an hour.

But for keeping this account of time, it may be done either by a Sand-glaſſe for that purpoſe, or by pronouncing certain words or numbers: As the time wherein a man tells twice 60, pronouncing every number as faſt as he can conveniently and diſtinctly, is about a minute; ſo that the time wherein a man is numbring 60, is a half minute or 30 *ſeconds*; and whileſt a man is numbring two (as one and twenty, two and twenty) is a ſecond; and ſo whileſt a man is numbring from twenty to thirty, is five *ſeconds*, from twenty to forty, ten *ſeconds*, *&c.* but in numbring from one to twenty, you may obſerve the ſame times, as in numbring from one and twenty to forty, and this will not be hard to do; for whileſt a man pronounceth one and twenty, two and twenty, three and twenty, *&c.* there remains a certain Impreſſion in the fantaſie, whereby a man is able in the ſame times to pronounce one, two, three, *&c.* And although this rule of numbring twice 60 for a minutes ſpace be not general unto all men, becauſe ſome are ſwifter or ſlower in their pronunciation than others; yet after this Example, a man making tryal, may frame a Rule to himſelf, whereby he may come ſomething neer the truth.

But leaving theſe, we come to the diviſion of the *Log-line*, according to the half-minute-glaſſe, which is more uſual and certain. And conſidering that half a minute is of an hour the $\frac{1}{120}$ part, therefore the ſhips way running 51 feet in half a minute is a mile an hour; if ſhe run twice ſo much, that is, 102 feet in half a minute, it is two miles an hour; if thrice ſo much, it is three miles an hour; And in general, how many times 51 feet ſhe runs in half a minute, ſo many miles is her way for an hour. Therefore leaving half a ſcore fathom, or more from the *Log*, that ſo it may be out of the *Eddy* of the ſhips wake, before you begin to account or turn the glaſſe; if there you make a mark for the beginning, and ſo 51 feet from thence a mark of one knot, and 51 feet further a mark of two knots, and 51 feet further (that is, 153 feet from your firſt mark) another mark of three knots,

and

and ſo proceeding: look how many knots are veered out in half a minute, ſo many miles is the ſhips way for an hour. Now for that which is veered out more above the juſt meaſure of a knot or knots, you may allow for every five feet the tenth part of a mile almoſt. As admit ſhe run 5 knots, and 25 feet in half a minute, then is her way according to $5\frac{1}{10}$ or five miles and an half in an hour, if ſix knots and ten feet it is $6\frac{2}{10}$ miles in an hour, *&c.*

But according to the common opinion of 5000 feet to a mile, and 60 ſuch miles to a Degree, there ſhould be ſomething leſſe then 7 fathom, namely, $41\frac{2}{3}$ feet to a knot.

And although he which veers the *Log-line* be careful to overhale it ſo ſlack, that it may not draw forwards the *Log*, yet (no doubt) it doth loſe ſome way, following the ſhip a little as it is drawn by the Line, and withall by the *Eddy* of the ſhips wake, and ſometimes alſo is caſt forwards by the wind and waves, when they come after the ſhip; ſo that for theſe cauſes, it is like, there may ſometimes be allowed three or four fathoms more then is veered out; but this (as a thing mutable and uncertain) being ſometimes more, ſometimes leſſe, cannot be brought to any certain Rule, but ſuch allowance may be made for it as a man in his experience and diſcretion finds fit.

If you would divide the *Log-line* ſo as it might give the ſhips way in *Centeſmes*, or the hundreth part of a Degree, and fit it to a half Minute-glaſſe. Then ſeeing the hundreth part of a Degree is 3672 feet, and the $\frac{1}{120}$ part thereof is $30\frac{3}{5}$ feet; If you begin at the mark at which you mean to turn the glaſſe, and meaſure from thence 30 feet, and three fifth parts of a foot, you may there place one knot; and thence again meaſuring 30 feet, and 3 fifth parts of a foot, there place two knots; and ſo proceeding at the end of every 30 feet and three fifths, adding a knot, the number of knots which run out in half a minute, is the number of *Centeſmes* which the ſhip runs in an hour. As ſuppoſe there run out ten knots in half a Minute, then the ſhips way is according to ten *Centeſmes* of a Degree in an hour, that is, the tenth part of a Degree, or ſix miles. And ſo every three foot above the juſt

just measure of knots, is neer the tenth part of a *Centesme*, or the 1000th part of a Degree. As if there run out of the *Log-line* 5 knots and 12 feet, then the ships way for an hour is 5 *Centesmes*, and four tenth parts of a *Centesme*: the like is to be understood of others.

And after the form of these examples you may divide the *Log-line* for any other quantity of Time, more or lesse than half a minute, or for any other parts of a Degree proposed.

Thus have we handled the division of the *Log-line*, according to the measure before found of 367200 *English*-feet in a Degree: But because (as I have before-shewed) the ships way is commonly more than by the *Log-line* it appears to be; and every man desires to have his reckoning something before his ship, that he fall not with a place unexpected; for these, and such other causes, and for the rotundity of the number, if any man think it more safe and convenient in Sea-reckonings, he may abate 1 in 51, and so assign to a degree only 360000 feet, and consequently to a mile 6000 *English*-feet.

And upon this ground, if in half a minute there run out 50 feet of the *Log-line*, it is a mile an hour; and so if 100 feet run out in a minute.

For, as 1 minute is in proportion to 60 minutes:

So is 100 feet, to 6000 feet.

And so forasmuch as twenty five feet is $\frac{1}{240}$ part of a mile, and 15 *seconds* is also $\frac{1}{240}$ part of an hour: Therefore if there be two marks on the Ships side distant 25 feet, if the ship run the distance of these two marks in 15 *seconds*, it is after the rate of a mile an hour; if in 5 *seconds*, it is three miles an hour; and so alwayes dividing 15 *seconds* by the number of *seconds* in which the ship runs that distance; the quotient shews the miles and parts of a mile run in an hour. But if the Distance of these two marks be 50 foot, then if she run it in 30 *seconds*, or half a minute, it is a mile an hour; if in 10 *seconds*, three miles an hour; if in five *seconds* six miles an hour, (for 30 divided by 5, the quotient is 6.) And so alwayes dividing 90 *seconds* by the number of *seconds*, in which the ship runnes that Distance;

ſtance; the quotient ſhews how many miles ſhe runs in an hour, *&c.*

Otherwiſe, if you make a mark on the ſhips ſide at every twenty Inches, then when the ſhip runs one of theſe parts in a ſecond of time, it is a mile an hour: when 5, it is 5 miles an hour: if ſhe run 18 of theſe parts in 3 ſeconds, it is 6 miles an hour. For dividing 18 by 3, the quotient is 6. And in general, if you divide the number of the parts run, by the number of ſeconds ſpent in running, the quotient ſhews the ſhips way in miles for an hour.

But for dividing the *Log-line* according to this ground of 6000 feet in a mile, if you intend to uſe it with a half Minute-glaſſe; then becauſe half a Minute is $\frac{1}{120}$ part of an hour, and 50 feet is alſo the $\frac{1}{120}$ part of a mile: Therefore when the ſhip runs 50 feet in half a Minute, her way is after the rate of a mile an hour; if 100 feet in half a minute, it is two miles an hour, *&c.*

Therefore half a ſcore fathoms or more from the *Log*, you may make a mark, and beginning from thence meaſure 50 feet, and there make the firſt knot, and 50 foot farther two knots, and 50 foot farther three knots, and ſo proceeding: Look how many knots is run out in half a minute, ſo many miles is the ſhips way for an hour. And every five feet more beſides the knots is a *tenth* part of a mile; As if there run out ſix knots and 20 feet in half a minute, the ſhips way is after the rate of $6\frac{2}{10}$ miles in an hour, *&c.*

And ſo if the Glaſſe were for any other time more or leſſe than half a minute, you may make the diſtance of your knots proportional: As if it were for 20 *ſeconds*, then becauſe 20 *ſeconds* is of an hour the $\frac{1}{180}$ part, I divide a mile, which is 6000 feet, by 180, and the quotient is $33\frac{1}{3}$; therefore there muſt be a knot at every 33 feet and 4 inches.

If your Glaſſe be 36 *ſeconds*, which is $\frac{1}{100}$ part of an hour, divide 6000 by 100, the quotient is 60, ſhewing that there muſt be 60 feet to every knot, and then every ſix foot over and above the knots, is a *tenth* part of a mile more.

And

And ſo it is better that your Glaſſe be more then half a minute rather than leſſe; and the more the better, provided that there run out no more Line then you may hale in again, without danger of breaking.

Laſtly, if you would ſo divide the *Log-line*, that it might ſhew the ſhips way in *Centeſmes* of a Degree, and fit it to an half-minute-glaſſe: Then foraſmuch as the hundreth part of a Degree is 3600 feet, and the $\frac{1}{120}$ part thereof is 30 feet; therefore beginning at the mark whereat you intend to turn the Glaſſe, meaſure from thence 30 feet, and there make one knot, and at thirty feet further two knots, *&c.* Then look how many knots run out in half a minute, ſo many *Centeſmes* of a Degree is the ſhips way for an hour. And ſo if the glaſſe be 36 *ſeconds*, then every knot muſt have 36 feet, *&c.*

Now if a man ſailing between any two Places which lie neer East and West one from another, have kept his reckoning by Courſe and Diſtance, uſing a *Log-line* ſo divided, that it have a knot at every 7 Fathoms (as many do) and would reduce the Diſtance of thoſe two places ſo found, to their Diſtance in ſuch miles, as theſe of ſixty to a Degree, each containing (as we have ſaid) 6000 Feet: The proportion in number of thoſe to theſe, is as 6 to 5: for 6 of them make 5 of theſe.

As admit a man in his dead Reckoning, uſing ſuch a *Log-line* as hath a knot at every 7 Fathoms, and for every knot running out in half a minute, he accounts the ſhips way to be ſo many miles an hour; and according to ſuch a reckoning, ſuppoſe he find the diſtance of two places to be 1224 Miles, or 408 leagues, and would know the Diſtance of the ſame places in miles of 6000 feet to a mile, which is according to a *Log-line* that hath a knot in every 50 feet.

Say then by the Rule of Proportion;

As the number 6	*Co. ar.*	9.22185
Is in proportion to 5.		0.69897
So is the number of miles given 1224		3.08778
To the number of miles required, 1020		3.00860

Which

Which 1020 is the distance of those two Places, in such miles whereof 60 make a Degree; Or to find the same in leagues, the proportion is; As 6 to 5; so is 408 leagues, to 340 leagues.

And thus may the Distances of places be found in such miles, whereof 60 make a Degree, especially if with the distance expressed in the *Plain Chart*, you compare the reckonings of some skilful Mariners that have sailed from the one to the other. But thus to endevour a reformation of the *Plain Chart* were a labour to little purpose; For there the correcting of the true situation of two places, in respect of one another, is oftentimes an occasion that the same places are the more falsly situate in respect of others. Like as if there were two places eight miles distant, and it were required to place a third three miles from either of them; Here if we set the third in the middle, it will be four miles distant from either: but if (attempting to mend that errour) we make the third to be 3 miles from the first, then will it be 5 miles from the second: And thus unavoidably, the mending of the one is the marring of the other; because the thing proposed is not possible.

And such is the errour of the Plain or Common *Sea-Chart*, representing the Earth and Sea, not as a Spherical, but as a Plain Superficies; not as if the Meridians did concurre in the Poles, but as if they were alwayes parallel one to another. So that the graduation and projection being such, the Situations and Distances of places, cannot be generally and truly expressed therein.

But the graduation and projection of *Mercators Chart*, agreeing without sensible errour with the *Globe*, there may in that be described all or any parts of the World, according to their Longitudes, Latitudes, Courses, and Distances, as truly and far more conveniently for the *Mariners* use then upon the Globe it self; and upon such a *Chart* so described, a reckoning may be truly kept, and any errour committed, may easily be discerned and amended. Whereas on the *Plain Chart*, if a man find his reckoning to disagree, he is so far from knowing how to amend it, that he can seldome conjecture where the fault was.

The neglect and want of these *Charts* hath been and is a great

imperfection in *Navigation* and *Geography*. For howſoever there be ſome which do daily ſet forth for ſale Maps of the World, and of the parts thereof, according to this Projection: Yet to have them truly ſuch, and fit for Navigation, requires in the Author or maker of them good knowledge, and ſome competent ability of his own, or aid from others with a greater love to the Truth than to his own profit, which may induce him to beſtow ſuch induſtry, time, and expence, as I have formerly noted to be requiſite in ſuch a Work.

For the furtherance whereof, and of the practice of Navigation in general, I ſhall endevour in the two next Chapters to ſhew a methodical and orderly way of keeping a reckoning at Sea, more diſtinctly and exactly than hath been formerly uſed, and ſuch as may aptly be ſet down in any Chart, and applied in the three principal kinds of Sailing; namely, according to the *Plain Chart*, or *Mercators*, or according to the Arch of a *Great Circle*. And by a few reckonings truly ſet down, according to this form, the Maps of the World, and of the parts thereof, might be much reformed.

CHAP. VIII.

A formal and exact way of ſetting down and perfecting a Sea-reckoning.

ALthough the Courſe and Diſtance cannot be ſo truly and certainly known as the Latitude may be: yet we muſt endevour in theſe alſo to come as near the Truth as may be, the rather for that ſome reckonings muſt neceſſarily depend wholly upon them. And to that end, thoſe which in their Voyages at Sea have occaſion to run far upon any Courſe or Courſes neer the Meridian, may do well to make tryal of that which I have formerly ſet down, touching the quantity of a Degree on the Earth and Sea in our known Meaſure; and eſpecially in *Eaſt-Indian* Voyages; ſayling from the *Lizard* in

in the West part of *England* to *Cape de bonne Esperance* in *Africk*, they have opportunity of making an ample Experiment hereof.

But leaving this to the practice of the skilful and industrious *Sea-man*, we come now to shew an orderly and exact way of framing and keeping a reckoning at Sea: for which purpose I have made the *Table* following, which sheweth how much a ship is more Northerly or Southerly, and how much more Easterly or Westerly, by sailing upon any point or half point of the *Compasse*, any number of miles proposed.

The like *Table* I made many years since, and taught the use of it in *Navigation*, whether it were then used by any other, I know not, I had it of no man; but this I speak, that if any man claim the first making and use of such an one, he may have it.

The ground of making this Table is the same with the former. *For as Radius is in proportion to the Distance run, So is the sine complement of the Rumb, to the distance of North or South, and so is the sine of the Rumb, to the distance of East or West.* Therefore here for ten miles upon any of the four points from the Meridian, we set in the second column the sine complement of that point (reduced into Degrees) and in the third the sine thereof. As the second Rumb or point from the Meridian, being 22 deg. 30 min. the sine complement thereof which is 9239 set in the second column against 10: and the sine thereof 3827, I set there in the third column; and having done thus for ten miles in every column, the rest may be easily drawn from them.

As in the second column, for the first half point against 10 miles finding 9952, I set the half thereof; namely 4976 against 5 miles, and the tenth part thereof, namely 995 against 1 mile, which doubled or added to it self is 1990, to be set against two miles, whereto adding the same 995, the sum is 2985 for three miles, and so for the rest.

And thus for every point and half point from the Meridian, there are three columns: In the first whereof there is set down a number of miles run upon that point or half point; the second sheweth how much the Latitude is altered; that

is, how much you are more Southerly or Northerly, by running so far upon that point or half point; The third, how much you are more Easterly or Westerly, by running that course and distance.

The Numbers set in every first column from 1 to 10, are also to be understood from 10 to 100, or from 100 to 1000, and the Figure in the fourth place of the second and third columns, answer to the figure in the first. As admit a ship run South and by West (that is (South 1 point Westerly) 165 miles) I set down this number thus; and looking in the Columns of the first *Rumb* against 10 (which may be understood to be 100) I find against it in the second column 981 almost, and in the third 195, also against 60 (that is 6) in the first column, there is 588 in the second, and 117 in the third: also against 5 in the first column, there is 49 in the second, and almost 10 in the third.

	100	981	195
S.W. 1.	60	588	117
point.	5	49	10
	165	161.8	32.2

These set down, and summ'd up, as here appeareth, shew that a Ship running *S* by *W* 165 miles, is to the Southwards of the place from whence she departed 161 miles and 8 tenth parts of a mile; and to the Westwards 32 miles, and 2 tenth parts of a mile. If you desire more exactnesse you may use all the places, for the first or greatest number, which is here 100.

	100	9808	1950
S.W. 1.	60	5885	1170
point.	5	490	97
	165.	161.83	32.17

As in the second Example, where the Southerly distance is $161\frac{81}{100}$ miles, and the Westerly $32\frac{17}{100}$ miles.

A Table

A Table of the Northing or Southing, Easting or Westing of every Rumb and half Rumb from the Meridian; according to the number of Miles run upon that Rumb.

	⅓ poin.	7½ poin.	1 poin.	7 poin.	1½ poin.	6½ poin.	2 poin.	6 poin.
M.	5. 37½	84 22½	11. 15	78. 45	16. 52	73. 7½	22. 30	67. 30
1	995	98	981	195	957	290	924	303
2	1990	196	1962	390	1914	580	1848	766
3	2986	294	2943	585	2871	870	2772	1148
4	3981	392	3923	780	3827	1161	3696	1531
5	4976	490	4904	975	4784	1451	4620	1914
6	5971	588	5885	1170	5741	1741	5544	2297
7	6966	686	6866	1365	6698	2031	6468	2680
8	7961	784	7846	1560	7655	2321	7392	3062
9	8957	882	8827	1 755	8612	2612	8315	3445
10	9952	980	9808	1950	9569	2902	9239	3827

	2½ poi.	5½ poin.	3 point.	5 poin.	3⅓ poi.	4½ poi.	4 poi.	4 poi.
M.	28. 7½	61. 52½	33. 45	56. 15	39. 22½	50. 37½	45. 00	45. 00
1	882	471	831	556	773	634	707	707
2	1764	942	1663	1111	1546	1269	1414	1414
3	2646	1414	2494	1667	2319	1903	2121	2121
4	3528	1885	3326	2222	3092	2538	2828	2828
5	4410	2357	4158	2778	3865	3172	3535	3535
6	5292	2828	4989	3334	4638	3806	4242	4242
7	6174	3300	5820	3890	5411	4440	4949	4949
8	7056	3771	6652	4445	6185	5075	5656	5656
9	7937	4243	7483	5000	6957	5710	6364	6364
10	8819	4714	8315	5556	7730	6344	7071	7071

A larger Example may be that before set down in the last *Problem* of Sailing by a *Great Circle* from *Summers-Islands* to the *Lizard*, pag. 127.

As

As admit I ſail from thence: Firſt, *N E* ½ point Eaſterly 600 miles, then *N E by E* 300 miles; East North-east half a point Northerly 465 miles; East *N E* 390 miles; *E N E*, ½ point Eaſterly 294 miles; *E* by *N* 210 miles; Eaſt 951 miles: Theſe Courſes and Diſtances I ſet down in ſuch form as here appeareth, where in the firſt Column there is expreſſed the Courſe or point of the Compaſſe upon which a man ſails: In the ſecond column, the Diſtance of that *Rumb* from the *Meridian*: In the third column, the Diſtance run upon that *Point*; In the reſt, the difference of *Latitude*, and departure from the *Meridian* in miles and *tenth* parts of a mile.

Courſe	*Rumb from me.*	*Diſt. miles.*	*North.*	*South.*	*Eaſt*	*Weſt.*
N E ½ *Po E.*	*North Eaſterly 4* ½ *P.*	600	380.6		463.8	
NE by E.	*N Eaſt 5 Point*	300	166.7		2494	
E N E ½ *Po. N.*	*N Eaſt 5* ½ *Po.*	400	1885		35228	
		90	424		794	
		5	24		44	
E N E	*N Eaſt 6 Po.*	300	1148		277.2	
		90	344		831	
E N E ½ *Po. E.*	*N Eaſt 6* ½ *Po.*	200	580		1914	
		60	174		574	
		4	12		38	
E by N	*N Eaſt 7 Po.*	200	390		1962	
		10	20		98	
		900			9510	
Eaſt	*Eaſt*	50				
		1				
		3210	1047.4		29197	

(In

(In all which is to be conceived, that the *Variations* are allowed) ſo that at the Foot of this reckoning, I find the ſumme of the North column to be $1047\frac{4}{10}$ miles, and the ſumme of the Eaſt column 2920 miles almoſt; the firſt, namely 1047 miles converted into degrees, is 17 degrees, 27 min. the difference of Latitude, which added to the Latitude of *Summers-Iſlands* 32 deg. 25 min. (where this reckoning began) the ſumme is 49 deg. 52 min. which is the Latitude of this laſt place where this reckoning endeth. So that according to this account, the Ship is run into the Latitude of 49 deg. 52 min. and hath altered her Longitude to the Eaſtwards 2920 miles, of ſuch miles, whereof 60 make a degree of a great Circle.

Therefore, if you ſet down this reckoning on the *Plain Chart*, you muſt make a point in the *Chart* that may be in the Latitude of 49 deg. 52 min. and to the Eaſtwards of *Summers-Iſlands*, (where this reckoning began) 2920 miles, that is, you muſt run a parallel (with your Compaſſes or otherwiſe) on your *Chart* in the Latitude of 49 degrees 52 minutes, and croſſe the ſame by a Meridian, which may be to the Eaſtwards of the Meridian of *Summers Iſlands* 2920 miles, and ſo the point of the interſection of this parallel and Meridian, is the Traverſe-point or point in the *Chart*, repreſenting the place where the Ship is in the end of this Reckoning.

But if you ſet down this reckoning on *Mercators Chart*, you muſt alſo find a point that may be in the Latitude of 29 deg. 52 min. and may likewiſe be to the Eaſtwards of *Summers-Iſlands* 2920 miles; which is done by running with your compaſſes a parallel in the Latitude of 49 deg. 52 min. and croſſing the ſame by a Meridian, which may be to the Eaſtwards of the Meridian of *Summers-Iſlands* 2920 miles, the point of the interſection of this parallel with that Meridian is the traverſe point, repreſenting in the *Chart* the place where the ſhip then is.

For it is to be conceived in this *Chart*, that the degrees of the Meridian intercepted between the Latitudes of two places are as a Scale for thoſe two places, to meaſure not only their difference of *Latitude*, but likewiſe their diſtance in their *Rumb*, as alſo the diſtance of their *Meridians*.

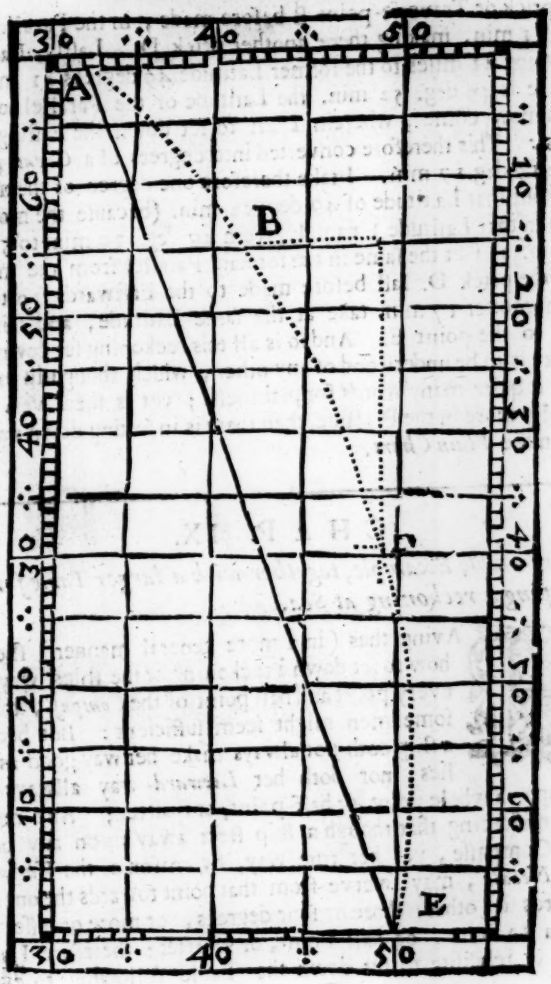
But

But becauſe it often falls out, that in ſailing from place to place, a ſhip runs not near the Rumb of the two places by many hundred miles, eſpecially in ſailing by the Arch of a *Great Circle*, which is the moſt exquiſite manner of ſailing, and wherein a man ſhifts his Courſe often, and runs much farther in one Latitude then in another, as by the former example may appear. Therefore once in three or four dayes, or ſo often as you alter your Courſe much, you may transfer or ſet down your Reckoning out of your Book into your *Chart*. As in transferring the former example, you may ſet down the Northing and Eaſting of every of the Courſes ſeverally; but for brevities ſake we will bring them into three parts (and ſo alſo we ſhall not much erre.)

And thus for the two firſt Courſes, namely *NE*$\frac{1}{2}$ point Eaſterly 600 miles, and *NE by E* 300 miles, I find in the North column 547 miles; and in the Eaſt column 713 miles: alſo for the three next Courſes ſumming up the North and Eaſt columns, I find the Northing to be 459 miles; and the Eaſting 1050 miles. Alſo for the two laſt Courſes, I find the Northing to be 41 miles, and the Eaſting 1157 miles.

North.	*Eaſt*
547	713
459	1050
41	1157
1047	2920

Now to transferre theſe into the *Chart*, I conſider that 547 miles is 9 degrees 7 minutes, which added to the former Latitude 32 deg. 25 min. makes latitude 41 deg. 32 min. In which Latitude I run a parallel, then conſidering that 713 miles is 11 deg. 53 min. I take this 11 deg. 53 min. in the Meridian, as much above the one Latitude, as beneath the other, namely, from 31 deg. 0 min. to 42 degrees 53 minutes, and this I ſet in the foreſaid parallel from the Meridian of *Summers-Iſlands* to the Eaſtwards, and there make the point B, then reducing 459 miles into deg. it makes 7 deg. 39 min. which added to 41 deg. 32 min. makes Latitude 49 deg. 11 min. Alſo the Eaſting 1050 miles are 17 deg. 30 min. the half whereof 8 deg. 45 min. I take in the Meridian from above 41 deg. 32 min. beneath 49 deg. 11 minutes, namely, from 41 deg. 20 min. to 50 deg. 5 min. And this being doubled (becauſe it is but the half) I ſet from the Meridian of the



I

the prick or Traverſe-point B before made, in the Parallel of 49 deg. 11 min. making there another prick D. Laſtly, I add the Northing 41 miles to the former Latitude 49 degrees 11 min. the ſumme is 49 deg. 52 min. the Latitude of the Parallel to which I am now come, wherein I am to ſet down the Eaſting 1157 miles: This therefore converted into degrees of a *Great Circle*, make 19 deg. 17 min. I take therefore one degree of the meridian, about that Latitude of 49 deg. 52 min. (becauſe the moſt part is run in that Latitude) namely, from 49 deg. 30. min. to 50 deg. 30 min. and ſet the ſame in the foreſaid Parallel from the meridian of the prick D. laſt before made to the Eaſtwards 19 times, and moreover 17 min. take at the ſame Latitude, and this reacheth to the point E. And ſo is all this reckoning ſet down, and the like is to be underſtood of any other, which though in expreſſion it require many words for plainneſſe; yet is there very little difficulty more in the Practice, then there is in ſetting down a reckoning on the *Plain Chart*.

CHAP. IX.

A more ample Example, together with a larger Table for the keeping a reckoning at Sea.

HAving thus (in a more general manner) ſhewed how to ſet down a reckoning of the ſhips way for every point and half point of the *Compaſs*, this to ſome men might ſeem ſufficient: But becauſe a ſhip doth not always make her way good as ſhe lies, nor doth her *Leeward*-way allways fall juſtly upon a whole point, or half-point, or quarter; And moreover, conſidering that though a ſhip ſteer away upon any point of the Compaſſe, yet her true way, by reaſon of the *Variation of the Needle*, may ſwerve from that point towards the one ſide or towards the other, three or four degrees, or more or leſſe, and not always a Point, or half Point, or quarter: therefore I have thought it requiſite to ſet down the Table following to every ſingle

ſingle Degree: and that a man might the more readily with one or two Entrances have his deſire, I have alſo enlarged the number of miles unto 100. The ground and way of making this Table differs not from the former, and it is to be uſed almoſt in the ſelf-ſame manner: wherefore we ſhall uſe the more brevity in handling of it.

Here followeth a Table of the Northing or Southing, Eaſting or Weſting of every Degree from the Meridian, according to the number of Miles run upon that Degree, which for brevity ſake we will call- - - -

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A

TABLE

FOR THE

DIFFERENCE

OF

LATITUDE,

AND

Departure from the *Meridian.*

M.	1d.	89d.	M.	1d.	89d.	Min.	1d.	89d.
1	10	0	35	350	6	69	690	12
2	20	0	36	360	7	70	700	12
3	30	0	37	370	7	71	710	13
4	40	1	38	380	7	72	720	13
5	50	1	39	390	7	73	730	13
6	60	1	40	400	7	74	740	13
7	70	1	41	410	7	75	750	13
8	80	1	42	420	7	76	760	13
9	90	2	43	430	8	77	770	14
10	100	2	44	440	8	78	780	14
11	110	2	45	450	8	79	790	14
12	120	2	46	460	8	80	800	14
13	130	2	47	470	8	81	810	14
14	140	2	48	480	9	82	820	14
15	150	3	49	490	9	83	830	15
16	160	3	50	500	9	84	840	15
17	170	3	51	510	9	85	850	15
18	180	3	52	520	9	86	860	15
19	190	3	53	530	9	87	870	15
20	200	4	54	540	10	88	880	15
21	210	4	55	550	10	89	890	16
22	220	4	56	560	10	90	900	16
23	230	4	57	570	10	91	910	16
24	240	4	58	580	10	92	920	16
25	250	4	59	590	10	93	930	16
26	260	5	60	600	11	94	940	17
27	270	5	61	610	11	95	950	17
28	280	5	62	620	11	96	960	17
29	290	5	63	630	11	97	970	17
30	300	5	64	640	11	98	980	17
31	310	5	65	650	12	99	990	17
32	320	6	66	660	12	100	1000	18
33	330	6	67	670	12	200	2000	35
34	340	6	68	680	12	300	3000	53

M.	2 d.	88 d.
1	10	0
2	20	1
3	30	1
4	40	1
5	50	2
6	60	2
7	70	2
8	80	3
9	90	3
10	100	3
11	110	4
12	120	4
13	130	4
14	140	5
15	150	5
16	160	6
17	170	6
18	180	6
19	190	7
20	200	7
21	210	7
22	220	8
23	230	8
24	240	8
25	250	9
26	260	9
27	270	9
28	280	10
29	290	10
30	300	10
31	310	11
32	320	11
33	330	11
34	340	12
35	350	12
36	360	13
37	370	13
38	380	13
39	390	14
40	400	14
41	410	14
42	420	15
43	430	15
44	440	15
45	450	16
46	460	16
47	470	16
48	480	17
49	490	17
50	500	17
51	510	18
52	520	18
53	530	18
54	540	19
55	550	19
56	560	19
57	570	20
58	580	20
59	590	20
60	600	21
61	610	21
62	620	22
63	630	22
64	640	22
65	650	23
66	660	23
67	670	23
68	680	24

Min.	2 d.	88 d.
69	690	24
70	700	24
71	710	25
72	720	25
73	730	25
74	740	26
75	750	26
76	760	26
77	770	27
78	780	27
79	790	28
80	800	28
81	809	28
82	819	29
83	829	29
84	839	29
85	849	30
86	859	30
87	869	30
88	879	31
89	889	31
90	899	31
91	909	32
92	919	32
93	929	32
94	939	33
95	949	33
96	959	34
97	969	34
98	979	34
99	989	35
100	999	35
200	1999	70
300	2998	105

M.	3.d.	87 d.
1	10	1
2	20	1
3	30	1
4	40	2
5	50	2
6	60	3
7	70	4
8	80	4
9	90	5
10	100	5
11	110	6
12	120	6
13	130	7
14	140	7
15	150	8
16	160	8
17	170	9
18	180	9
19	190	10
20	200	10
21	210	11
22	220	11
23	230	12
24	240	12
25	250	13
26	260	13
27	270	14
28	280	15
29	290	15
30	300	16
31	310	16
32	320	17
33	330	17
34	340	18

M.	3 d.	87 d.
35	350	18
36	360	19
37	370	19
38	380	20
39	390	20
40	400	21
41	410	21
42	420	22
43	430	22
44	440	23
45	450	23
46	460	24
47	470	24
48	480	25
49	490	26
50	500	26
51	509	27
52	519	27
53	529	28
54	539	28
55	549	29
56	559	29
57	569	30
58	579	30
59	589	31
60	599	31
61	609	32
62	619	32
63	629	33
64	639	33
65	649	34
66	659	35
67	669	35
68	679	36

Min.	3.d.	87 d.
69	689	36
70	699	37
71	709	37
72	719	38
73	729	38
74	739	39
75	749	39
76	759	40
77	769	40
78	779	41
79	789	41
80	799	42
81	809	42
82	819	43
83	829	43
84	839	44
85	849	44
86	859	45
87	869	45
88	879	46
89	889	46
90	899	47
91	909	48
92	919	48
93	929	49
94	939	49
95	949	50
96	959	50
97	969	51
98	979	51
99	989	52
100	999	52
200	1997	105
300	2996	157

M.	4 d.	86 d.	M.	4 d.	86 d.	Min.	4 d.	80 d.
1	10	1	35	349	25	69	688	48
2	20	1	36	359	25	70	698	49
3	30	2	37	369	26	71	708	50
4	40	3	38	379	27	72	718	50
5	50	3	39	389	27	73	728	51
6	60	4	40	399	28	74	738	52
7	70	5	41	409	29	75	748	52
8	80	6	42	419	29	76	758	53
9	90	6	43	429	30	77	768	54
10	100	7	44	439	31	78	778	55
11	110	8	45	449	31	79	788	55
12	120	8	46	459	32	80	798	56
13	130	9	47	469	33	81	808	57
14	140	10	48	479	34	82	818	57
15	150	10	49	489	34	83	828	58
16	160	11	50	499	35	84	838	59
17	170	12	51	509	36	85	848	59
18	180	13	52	519	36	86	858	60
19	190	13	53	529	37	87	868	61
20	200	14	54	539	38	88	878	61
21	209	15	55	549	38	89	888	62
22	219	15	56	559	39	90	898	63
23	229	16	57	569	40	91	908	63
24	239	17	58	579	40	92	918	64
25	249	17	59	589	41	93	928	65
26	259	18	60	599	42	94	938	66
27	269	19	61	609	43	95	948	66
28	279	20	62	619	43	96	958	67
29	289	20	63	629	44	97	968	68
30	299	21	64	639	45	98	978	68
31	309	22	65	648	45	99	988	69
32	319	22	66	658	46	100	998	70
33	329	23	67	668	47	200	1995	140
34	339	24	68	678	48	300	2993	209

M.	5. d.	85 d.	M.	5. d.	85 d.	Min.	5. d.	85 d.
1	10	1	35	349	30	69	687	60
2	20	2	36	359	31	70	697	61
3	30	3	37	369	32	71	707	62
4	40	3	38	379	33	72	717	63
5	50	4	39	388	34	73	727	64
6	60	5	40	398	35	74	737	65
7	70	6	41	408	36	75	747	65
8	80	7	42	418	37	76	757	66
9	90	8	43	428	37	77	767	67
10	100	9	44	438	38	78	777	68
11	110	10	45	448	39	79	787	69
12	120	10	46	458	40	80	797	70
13	130	11	47	468	41	81	807	71
14	140	12	48	478	42	82	817	71
15	150	13	49	488	43	83	827	72
16	160	14	50	498	44	84	837	73
17	170	15	51	508	45	85	847	74
18	180	16	52	518	45	86	857	75
19	190	17	53	528	46	87	867	76
20	200	17	54	538	47	88	877	77
21	209	18	55	548	48	89	887	78
22	219	19	56	558	49	90	897	78
23	229	20	57	568	50	91	907	79
24	239	21	58	578	51	92	916	80
25	249	22	59	588	52	93	926	81
26	259	22	60	598	52	94	936	82
27	269	24	61	608	53	95	946	83
28	279	24	62	618	54	96	956	84
29	289	25	63	628	55	97	966	84
30	299	26	64	638	56	98	976	85
31	309	27	65	648	57	99	986	86
32	319	28	66	658	58	100	996	87
33	329	29	67	668	58	200	1992	174
34	339	30	68	677	59	300	2989	262

M.	6. d.	84 d.
1	10	1
2	20	2
3	30	3
4	40	4
5	50	5
6	60	6
7	70	7
8	80	8
9	89	9
10	99	10
11	109	11
12	119	12
13	129	14
14	139	15
15	149	16
16	159	17
17	169	18
18	179	19
19	189	20
20	199	21
21	209	22
22	219	23
23	229	24
24	239	25
25	249	26
26	259	27
27	265	28
28	278	29
29	288	30
30	298	31
31	308	32
32	318	33
33	328	34
34	338	35

M.	6. d.	84 d.
35	348	36
36	358	38
37	368	39
38	378	40
39	388	41
40	398	42
41	408	43
42	418	44
43	428	45
44	438	46
45	447	47
46	457	48
47	467	49
48	477	50
49	487	51
50	497	52
51	507	53
52	517	54
53	527	55
54	537	56
55	547	57
56	557	58
57	567	59
58	577	61
59	587	62
60	597	63
61	607	64
62	617	65
63	627	66
64	637	67
65	646	68
66	656	69
67	666	70
68	676	71

Min.	6. d.	84 d.
69	686	72
70	696	73
71	706	74
72	716	75
73	726	76
74	736	77
75	746	78
76	756	79
77	766	80
78	776	81
79	786	82
80	796	83
81	806	85
82	815	86
83	825	87
84	835	88
85	845	89
86	855	90
87	865	91
88	875	92
89	885	93
90	895	94
91	905	95
92	915	96
93	925	97
94	935	98
95	945	99
96	955	100
97	965	101
98	975	102
99	985	103
100	995	104
200	1980	209
300	2983	313

M.	7. d.	83 d.
1	10	1
2	20	2
3	30	4
4	40	5
5	50	6
6	60	7
7	69	8
8	79	10
9	89	11
10	99	12
11	109	13
12	119	15
13	129	16
14	139	17
15	149	18
16	159	20
17	169	21
18	179	22
19	189	23
20	199	24
21	208	26
22	218	27
23	228	28
24	238	29
25	248	30
26	258	32
27	268	33
28	278	34
29	288	35
30	298	37
31	308	38
32	318	39
33	327	40
34	337	41

M.	7. d.	83 d.
35	347	43
36	357	44
37	367	45
38	377	46
39	387	48
40	397	49
41	407	50
42	417	51
43	427	52
44	437	54
45	447	55
46	456	56
47	466	57
48	476	59
49	486	60
50	496	61
51	506	62
52	516	63
53	526	65
54	536	66
55	546	67
56	556	68
57	566	69
58	576	71
59	586	72
60	596	73
61	605	74
62	615	76
63	625	77
64	635	78
65	645	79
66	655	81
67	665	82
68	675	83

Min.	7. d.	83 d.
69	685	84
70	695	85
71	705	87
72	715	88
73	725	89
74	734	90
75	744	92
76	754	93
77	764	94
78	774	95
79	784	96
80	794	98
81	804	99
82	814	100
83	824	101
84	834	103
85	844	104
86	854	105
87	863	106
88	873	107
89	883	109
90	893	110
91	903	111
92	913	112
93	923	113
94	933	115
95	943	116
96	953	117
97	963	118
98	973	120
99	983	121
100	993	122
200	1985	244
300	2977	366

M.	8 d.	82 d.	M.	8 d.	82 d.	Min.	8 d.	82 d.
1	10	1	35	347	49	69	683	90
2	20	3	36	357	50	70	693	97
3	30	4	37	366	51	71	703	99
4	40	6	38	376	53	72	713	100
5	50	7	39	386	54	73	725	102
6	59	8	40	396	56	74	733	103
7	69	10	41	406	57	75	743	104
8	79	11	42	416	58	76	753	106
9	89	13	43	426	60	77	763	107
10	99	14	44	436	61	78	772	109
11	109	15	45	446	63	79	782	110
12	119	17	46	456	64	80	792	111
13	129	18	47	466	65	81	802	113
14	139	19	48	475	67	82	812	114
15	148	21	49	485	68	83	822	115
16	158	22	50	495	70	84	832	117
17	168	24	51	505	71	85	842	118
18	178	25	52	515	72	86	852	120
19	188	26	53	525	74	87	862	121
20	198	28	54	535	75	88	872	122
21	208	29	55	545	77	89	881	124
22	218	31	56	555	78	90	891	125
23	228	32	57	565	79	91	901	127
24	238	33	58	574	81	92	911	128
25	248	35	59	584	82	93	921	129
26	257	36	60	594	83	94	931	131
27	267	38	61	604	85	95	941	132
28	277	39	62	614	86	96	951	134
29	287	40	63	624	88	97	961	135
30	297	42	64	634	89	98	970	136
31	307	43	65	644	90	99	980	138
32	317	44	66	654	92	100	990	139
33	327	46	67	664	93	200	1981	278
34	337	47	68	674	95	300	2971	418

M.	9 d.	81 d.
1	10	2
2	20	3
3	30	5
4	40	6
5	50	8
6	59	9
7	69	11
8	79	13
9	89	14
10	99	16
11	109	17
12	119	19
13	129	20
14	138	22
15	148	23
16	158	25
17	168	26
18	178	28
19	188	30
20	198	31
21	208	33
22	217	34
23	227	36
24	237	37
25	247	39
26	257	41
27	267	42
28	277	44
29	287	45
30	296	47
31	306	48
32	316	50
33	326	51
34	336	53

M.	9 d.	81 d.
35	346	55
36	356	56
37	366	58
38	375	59
39	385	61
40	395	63
41	405	64
42	415	66
43	425	67
44	435	69
45	445	70
46	454	72
47	464	73
48	474	75
49	484	77
50	494	78
51	504	80
52	514	81
53	524	83
54	534	84
55	543	86
56	553	88
57	563	89
58	573	91
59	583	92
60	593	94
61	603	95
62	612	97
63	622	98
64	632	100
65	642	102
66	652	103
67	662	105
68	672	106

Min.	9 d.	81 d.
69	682	108
70	691	109
71	701	111
72	711	112
73	721	114
74	731	116
75	741	117
76	751	119
77	761	120
78	770	122
79	780	124
80	790	125
81	800	127
82	810	128
83	820	130
84	830	131
85	840	133
86	850	134
87	859	136
88	859	138
89	879	139
90	889	141
91	899	142
92	909	144
93	919	145
94	929	147
95	938	148
96	948	150
97	958	152
98	968	153
99	978	155
100	988	156
200	1975	213
300	2963	369

M.	10 d	80 d.
1	10	2
2	20	3
3	30	5
4	39	7
5	49	9
6	59	10
7	69	12
8	79	14
9	89	16
10	99	17
11	108	19
12	118	21
13	128	23
14	138	24
15	148	26
16	158	28
17	168	30
18	177	31
19	187	33
20	197	35
21	207	36
22	217	38
23	227	40
24	236	42
25	246	43
26	256	45
27	266	47
28	276	49
29	286	50
30	296	52
31	305	54
32	315	55
33	325	57
34	333	59

M.	10 d.	80 d.
35	345	61
36	355	62
37	363	64
38	374	66
39	384	68
40	394	69
41	404	71
42	414	73
43	424	75
44	433	76
45	443	78
46	453	80
47	463	81
48	473	83
49	483	85
50	492	87
51	502	88
52	512	90
53	522	92
54	532	94
55	542	95
56	552	97
57	561	99
58	571	101
59	581	102
60	591	104
61	601	106
62	611	108
63	620	119
64	630	111
65	640	113
66	650	115
67	660	116
68	670	118

Min.	10. d.	80 d.
69	680	120
70	689	121
71	699	123
72	709	125
73	719	127
74	729	128
75	739	130
76	749	132
77	758	133
78	768	135
79	778	137
80	788	139
81	798	141
82	808	142
83	817	144
84	827	146
85	837	148
86	847	149
87	857	151
88	867	153
89	876	154
90	886	156
91	896	158
92	906	160
93	916	161
94	926	163
95	936	165
96	946	167
97	955	168
98	965	170
99	975	172
100	985	174
200	1970	347
300	2954	521

M.	11d.	79d
1	10	2
2	20	4
3	29	6
4	39	8
5	49	9
6	59	11
7	69	13
8	78	15
9	88	17
10	98	19
11	108	21
12	118	23
13	128	25
14	137	27
15	147	29
16	157	30
17	167	32
18	177	34
19	185	36
20	196	38
21	206	40
22	216	42
23	226	44
24	236	46
25	245	48
26	255	50
27	265	51
28	275	53
29	285	55
30	294	57
31	304	59
32	314	61
33	324	63
34	334	65

M.	11d.	79d.
35	343	67
36	353	69
37	363	71
38	373	72
39	383	74
40	393	76
41	402	78
42	412	80
43	422	82
44	432	84
45	442	86
46	452	88
47	461	90
48	471	92
49	481	93
50	491	95
51	501	97
52	510	99
53	520	101
54	530	103
55	540	105
56	550	107
57	559	109
58	569	111
59	579	112
60	589	114
61	599	116
62	609	118
63	618	120
64	628	122
65	638	124
66	648	126
67	658	128
68	668	130

Min.	11d.	79d.
69	677	132
70	687	134
71	697	135
72	707	137
73	716	139
74	726	141
75	736	143
76	746	145
77	756	147
78	765	149
79	775	151
80	785	153
81	795	154
82	805	156
83	815	158
84	824	160
85	834	162
86	844	164
87	854	166
88	864	168
89	873	170
90	883	172
91	893	174
92	903	176
93	913	177
94	923	179
95	932	181
96	942	183
97	952	185
98	962	187
99	972	189
100	981	191
200	1963	382
300	2944	572

M.	12 d	78 d.
1	10	2
2	20	4
3	29	6
4	39	8
5	49	10
6	59	12
7	69	15
8	78	17
9	88	19
10	98	21
11	108	23
12	117	25
13	127	27
14	137	29
15	147	31
16	156	33
17	166	36
18	176	38
19	186	40
20	196	42
21	205	44
22	215	46
23	225	48
24	235	50
25	245	52
26	254	54
27	264	56
28	274	58
29	284	60
30	293	62
31	303	64
32	313	66
33	323	69
34	333	71

M.	12d.	78d
35	342	73
36	352	75
37	362	77
38	372	79
39	381	81
40	391	83
41	401	85
42	411	87
43	420	90
44	430	92
45	440	94
46	450	96
47	460	98
48	470	100
49	479	102
50	489	104
51	599	106
52	509	108
53	518	110
54	528	112
55	538	114
56	548	116
57	558	118
58	567	121
59	577	123
60	587	125
61	597	127
62	607	129
63	616	131
64	626	133
65	636	135
66	646	137
67	655	140
68	665	142

Min.	12. d.	78 d.
69	675	144
70	685	146
71	694	148
72	704	150
73	714	152
74	724	154
75	734	156
76	744	158
77	753	160
78	763	162
79	773	164
80	783	166
81	792	168
82	802	170
83	812	173
84	822	175
85	831	177
86	841	179
87	851	181
88	861	183
89	871	185
90	880	187
91	890	189
92	900	191
93	910	193
94	920	195
95	929	197
96	939	200
97	949	202
98	959	204
99	968	206
100	978	208
200	1956	416
300	2934	624

M.	13d.	77d.
1	10	2
2	20	4
3	29	7
4	39	9
5	49	11
6	59	13
7	68	16
8	78	18
9	88	20
10	98	22
11	107	25
12	117	27
13	127	29
14	136	31
15	146	34
16	156	36
17	166	38
18	176	40
19	185	43
20	195	45
21	205	47
22	215	49
23	224	52
24	234	54
25	244	56
26	254	58
27	263	61
28	273	63
29	283	65
30	292	67
31	302	70
32	312	72
33	322	74
34	331	76

M.	13d.	77d.
35	341	79
36	351	81
37	361	83
38	370	86
39	380	88
40	390	90
41	400	92
42	409	94
43	419	97
44	429	99
45	438	101
46	448	103
47	458	106
48	468	108
49	477	110
50	487	112
51	497	115
52	507	117
53	516	119
54	526	121
55	536	124
56	546	126
57	555	128
58	565	130
59	575	133
60	585	135
61	594	137
62	604	140
63	614	142
64	624	144
65	634	146
66	643	148
67	653	151
68	663	153

Min.	13d.	77d.
69	672	155
70	682	157
71	692	160
72	702	162
73	711	164
74	721	166
75	731	169
76	741	171
77	750	173
78	760	175
79	770	178
80	780	180
81	789	182
82	799	184
83	809	187
84	818	189
85	828	191
86	838	193
87	848	196
88	857	198
89	867	200
90	877	202
91	887	205
92	896	207
93	906	209
94	916	211
95	926	214
96	935	216
97	945	218
98	955	221
99	965	223
100	974	225
200	1949	450
300	2923	675

M.	14d.	76d.
1	10	2
2	19	5
3	29	7
4	39	10
5	48	12
6	58	14
7	68	17
8	78	19
9	87	22
10	97	24
11	107	27
12	116	29
13	126	31
14	136	34
15	146	36
16	155	39
17	165	41
18	175	44
19	184	46
20	194	48
21	204	51
22	213	53
23	223	56
24	233	58
25	242	60
26	252	63
27	262	65
28	272	68
29	281	70
30	291	73
31	301	75
32	310	77
33	320	80
34	330	82
35	340	85
36	349	87
37	359	90
38	369	92
39	378	94
40	388	97
41	398	99
42	407	102
43	417	104
44	427	107
45	437	109
46	446	111
47	456	114
48	466	116
49	475	119
50	485	121
51	495	123
52	504	126
53	514	128
54	524	131
55	534	133
56	543	136
57	553	138
58	563	140
59	572	143
60	582	145
61	592	148
62	601	150
63	611	153
64	621	155
65	631	157
66	640	160
67	650	162
68	660	165

Min.	14d.	76d.
69	669	167
70	679	169
71	689	172
72	698	174
73	708	177
74	718	179
75	428	182
76	737	184
77	747	187
78	757	189
79	766	191
80	776	194
81	786	195
82	796	197
83	805	200
84	815	202
85	825	205
86	834	207
87	844	209
88	854	213
89	864	215
90	873	218
91	883	220
92	893	223
93	902	225
94	912	227
95	921	230
96	931	232
97	941	235
98	951	237
99	960	240
100	970	242
200	1941	484
300	2911	726

M.	15 d.	75 d.
1	10	3
2	19	5
3	29	8
4	39	10
5	48	13
6	58	16
7	68	18
8	177	21
9	187	23
10	197	26
11	106	28
12	116	31
13	126	34
14	135	36
15	145	39
16	155	41
17	164	44
18	174	47
19	183	49
20	193	52
21	203	54
22	213	57
23	222	60
24	233	62
25	242	65
26	251	67
27	261	70
28	271	73
29	280	75
30	290	78
31	299	80
32	309	83
33	319	85
34	328	88

M.	15 d.	75 d.
35	338	91
36	348	93
37	357	96
38	367	98
39	377	101
40	386	103
41	396	106
42	406	109
43	415	111
44	425	114
45	435	116
46	444	119
47	454	123
48	464	125
49	473	128
50	483	129
51	493	132
52	502	135
53	512	137
54	522	140
55	531	142
56	541	145
57	551	148
58	560	150
59	570	153
60	580	155
61	589	158
62	599	160
63	608	163
64	618	166
65	628	168
66	638	171
67	647	174
68	657	176

Min.	15 d.	75 d.
69	666	179
70	676	181
71	686	184
72	696	186
73	705	189
74	715	192
75	424	194
76	734	197
77	744	200
78	754	202
79	763	205
80	773	207
81	783	210
82	792	212
83	802	215
84	811	217
85	821	220
86	831	223
87	840	225
88	850	228
89	860	230
90	869	233
91	879	236
92	889	238
93	898	241
94	908	243
95	918	246
96	927	248
97	937	251
98	947	254
99	956	256
100	966	259
200	1932	518
300	2898	776

M.	16 d	74 d.
1	10	3
2	19	6
3	29	8
4	38	11
5	48	14
6	58	17
7	67	19
8	77	22
9	86	25
10	96	28
11	106	30
12	115	33
13	125	36
14	134	39
15	144	41
16	154	44
17	163	47
18	173	50
19	183	53
20	192	55
21	202	58
22	211	61
23	222	63
24	231	66
25	240	69
26	250	72
27	259	75
28	269	77
29	279	80
30	288	83
31	298	85
32	308	88
33	317	91
34	327	94

M.	16 d	74 d.
35	336	97
36	346	99
37	356	102
38	365	105
39	375	107
40	384	110
41	394	113
42	404	116
43	413	119
44	423	121
45	432	124
46	442	127
47	452	130
48	461	132
49	471	135
50	481	138
51	490	141
52	500	143
53	509	146
54	519	149
55	529	151
56	538	154
57	548	157
58	557	160
59	567	163
60	577	165
61	586	168
62	596	171
63	606	174
64	615	177
65	625	179
66	634	182
67	644	185
68	654	188

Min.	16 d.	74 d
69	663	190
70	673	193
71	682	196
72	692	199
73	702	201
74	711	204
75	721	207
76	731	210
77	740	213
78	750	215
79	759	218
80	769	220
81	779	223
82	788	226
83	798	229
84	807	232
85	817	235
86	827	237
87	836	240
88	846	243
89	856	245
90	865	248
91	875	251
92	884	254
93	894	257
94	904	259
95	913	262
96	923	265
97	932	267
98	942	270
99	952	273
100	961	276
200	1925	551
300	2884	827

M.	17 d.	73 d.	M.	17 d.	73 d.	Min.	17 d.	73 d.
1	10	3	35	335	102	69	660	202
2	19	6	36	344	105	70	669	205
3	29	9	37	354	108	71	679	207
4	38	12	38	363	111	72	688	210
5	48	15	39	373	114	73	698	213
6	57	17	40	383	117	74	708	216
7	67	20	41	392	120	75	717	219
8	76	23	42	402	123	76	727	222
9	86	26	43	411	126	77	736	225
10	96	29	44	421	129	78	746	228
11	105	32	45	430	131	79	755	231
12	115	35	46	440	134	80	765	234
13	124	38	47	449	137	81	775	237
14	134	41	48	459	140	82	784	240
15	143	44	49	459	143	83	794	243
16	153	47	50	478	146	84	803	246
17	162	50	51	488	149	85	813	248
18	172	52	52	497	152	86	822	251
19	182	55	53	507	155	87	832	254
20	191	58	54	516	158	88	842	257
21	201	61	55	526	161	89	851	260
22	210	64	56	535	164	90	861	263
23	220	67	57	545	167	91	870	266
24	230	70	58	554	170	92	880	269
25	239	73	59	564	172	93	889	272
26	249	76	60	574	175	94	899	275
27	258	79	61	583	178	95	908	278
28	268	82	62	693	181	96	918	281
29	277	85	63	602	184	97	927	284
30	287	88	64	612	187	98	937	287
31	296	91	65	622	190	99	947	289
32	306	93	66	631	193	100	956	292
33	316	96	67	643	196	200	1913	585
34	325	99	68	650	199	300	2869	877

M.	18 d	72 d.
1	10	3
2	19	6
3	28	9
4	38	12
5	47	15
6	57	18
7	66	22
8	76	25
9	85	28
10	95	31
11	104	34
12	114	37
13	123	40
14	133	43
15	142	46
16	152	50
17	161	53
18	171	56
19	180	59
20	190	62
21	200	65
22	209	68
23	219	71
24	228	74
25	238	77
26	247	81
27	257	84
28	266	87
29	276	90
30	285	93
31	295	96
32	304	99
33	314	102
34	323	105

M.	18 d.	72 d.
35	333	108
36	342	111
37	352	114
38	361	117
39	371	120
40	380	124
41	390	127
42	398	130
43	408	133
44	417	136
45	427	139
46	436	142
47	446	145
48	455	148
49	465	151
50	476	154
51	485	158
52	495	161
53	504	164
54	514	167
55	523	170
56	533	173
57	542	176
58	552	179
59	561	182
60	571	185
61	580	188
62	598	192
63	599	195
64	609	198
65	618	201
66	628	204
67	637	207
68	647	210

Min.	18 d	72 d.
69	656	213
70	666	216
71	675	219
72	685	222
73	694	225
74	704	229
75	713	232
76	723	235
77	732	238
78	742	241
79	751	244
80	761	247
81	770	250
82	780	253
83	789	256
84	799	260
85	808	263
86	818	266
87	827	269
88	837	272
89	846	275
90	856	278
91	865	281
92	875	284
93	884	287
94	894	290
95	903	293
96	913	297
97	922	300
98	932	303
99	941	306
100	951	309
200	1902	618
300	2850	927

M.	19 d	71 d.
1	9	3
2	19	6
3	28	10
4	38	13
5	47	16
6	57	20
7	66	23
8	75	26
9	85	29
10	94	33
11	104	36
12	113	39
13	123	42
14	132	46
15	142	49
16	151	52
17	161	55
18	170	59
19	180	62
20	189	65
21	199	68
22	208	72
23	217	75
24	227	78
25	236	82
26	246	85
27	255	88
28	265	91
29	274	94
30	284	98
31	293	101
32	303	104
33	312	107
34	321	111

M.	19 d.	71 d.
35	331	114
36	340	117
37	350	121
38	359	124
39	369	127
40	378	130
41	388	134
42	397	137
43	407	140
44	416	143
45	425	147
46	435	150
47	444	153
48	454	156
49	463	160
50	473	163
51	482	166
52	492	169
53	501	173
54	510	176
55	520	179
56	529	182
57	539	186
58	548	189
59	558	192
60	567	195
61	577	199
62	586	202
63	596	205
64	605	208
65	615	212
66	624	015
67	634	118
68	643	222

Min.	19 d	81 d.
69	652	225
70	662	228
71	671	231
72	681	234
73	690	238
74	699	241
75	709	244
76	718	247
77	728	251
78	737	254
79	747	257
80	756	261
81	766	264
82	775	267
83	785	270
84	794	274
85	804	277
86	813	280
87	822	283
88	832	287
89	841	290
90	851	293
91	860	296
92	870	300
93	879	303
94	889	306
95	898	309
96	908	313
97	917	316
98	926	319
99	936	322
100	945	326
200	1891	651
300	2836	977

M.	20 d	70 d.
1	9	3
2	19	7
3	28	10
4	38	14
5	47	17
6	56	20
7	65	24
8	75	27
9	85	31
10	94	34
11	103	38
12	113	41
13	122	44
14	132	48
15	141	51
16	150	55
17	160	58
18	169	61
19	179	65
20	188	68
21	197	72
22	207	75
23	216	79
24	226	82
25	235	85
26	244	89
27	254	92
28	263	96
29	272	100
30	282	103
31	291	106
32	301	109
33	310	113
34	319	116

M.	20 d.	70 d
35	329	120
36	338	123
37	348	126
38	357	130
39	366	133
40	376	137
41	385	140
42	395	144
43	404	147
44	413	150
45	423	154
46	432	157
47	442	161
48	451	164
49	460	168
50	470	171
51	479	174
52	489	178
53	498	181
54	507	185
55	517	188
56	526	191
57	536	195
58	545	198
59	554	202
60	564	205
61	573	209
62	583	212
63	592	215
64	601	219
65	611	222
66	620	226
67	630	229
68	639	233

Min.	20. d.	70 d.
69	648	236
70	658	239
71	667	243
72	677	246
73	686	250
74	695	253
75	705	256
76	714	260
77	724	263
78	733	267
79	742	270
80	752	274
81	761	277
82	771	280
83	780	284
84	789	287
85	800	291
86	808	294
87	818	298
88	827	301
89	836	304
90	846	308
91	855	311
92	864	315
93	874	318
94	883	321
95	893	325
96	902	328
97	912	332
98	921	335
99	930	339
100	940	342
200	1879	684
300	2819	1026

M.	21 d	69 d.
1	9	4
2	19	7
3	28	11
4	37	14
5	47	18
6	56	21
7	65	25
8	75	29
9	84	32
10	93	36
11	103	39
12	112	43
13	121	47
14	131	50
15	140	54
16	149	57
17	159	61
18	168	64
19	177	68
20	187	72
21	196	75
22	205	79
23	215	82
24	224	86
25	233	90
26	243	93
27	252	97
28	261	100
29	271	104
30	280	107
31	289	111
32	299	115
33	308	118
34	317	122

M.	21d.	69d
35	327	125
36	336	129
37	345	132
38	355	136
39	364	140
40	373	143
41	383	147
42	392	150
43	401	154
44	411	158
45	420	161
46	429	165
47	439	168
48	448	172
49	457	176
50	467	179
51	476	183
52	485	186
53	495	190
54	504	193
55	513	197
56	523	201
57	532	204
58	541	208
59	551	211
60	560	215
61	569	219
62	579	222
63	588	226
64	598	229
65	607	233
66	616	236
67	626	240
68	635	244

Min.	21. d.	69 d.
69	644	247
70	653	251
71	663	254
72	672	258
73	681	262
74	691	265
75	700	269
76	709	272
77	719	276
78	728	279
79	737	283
80	747	287
81	756	290
82	766	294
83	775	297
84	784	301
85	794	305
86	803	308
87	812	312
88	822	315
89	831	319
90	840	323
91	849	326
92	859	330
93	868	333
94	877	337
95	887	340
96	896	344
97	905	348
98	915	351
99	924	355
100	934	358
200	1867	717
300	1801	1075

M.	22 d.	68 d.
1	9	4
2	19	7
3	28	11
4	37	15
5	46	19
6	56	22
7	65	26
8	74	30
9	83	34
10	93	37
11	102	41
12	111	45
13	120	49
14	130	52
15	139	55
16	148	60
17	157	64
18	167	67
19	176	71
20	185	75
21	195	79
22	204	82
23	213	86
24	222	90
25	232	94
26	241	97
27	250	101
28	260	105
29	269	109
30	278	112
31	287	116
32	297	120
33	306	124
34	315	127

M.	22 d.	68 d.
35	324	131
36	334	135
37	343	139
38	352	142
39	361	146
40	371	150
41	380	154
42	389	157
43	399	161
44	408	165
45	417	169
46	426	172
47	436	176
48	445	180
49	454	184
50	464	187
51	473	191
52	482	195
53	491	299
54	501	202
55	510	206
56	519	210
57	529	214
58	538	217
59	547	221
60	556	225
61	566	229
62	575	232
63	584	236
64	594	240
65	603	244
66	612	247
67	621	251
68	631	255

Min.	22 d.	68 d.
69	640	259
70	649	262
71	658	266
72	667	270
73	677	274
74	686	277
75	695	281
76	705	285
77	714	289
78	723	292
79	733	296
80	742	300
81	751	304
82	760	307
83	770	311
84	779	315
85	788	319
86	797	322
87	806	326
88	816	330
89	825	334
90	834	337
91	844	341
92	853	345
93	862	349
94	871	352
95	881	356
96	890	360
97	899	364
98	909	367
99	918	371
100	927	375
200	1854	749
300	2782	1094

M.	23 d	67 d.
1	9	4
2	18	8
3	28	12
4	37	16
5	46	19
6	55	23
7	64	27
8	74	31
9	83	35
10	92	39
11	101	43
12	110	47
13	120	51
14	129	55
15	138	59
16	147	62
17	156	66
18	166	70
19	175	74
20	184	78
21	193	82
22	202	86
23	212	90
24	221	94
25	230	98
26	239	102
27	248	105
28	258	109
29	267	113
30	276	117
31	285	121
32	294	125
33	304	129
34	313	133

M.	23 d	67 d.
35	322	137
36	331	141
37	340	144
38	350	148
39	359	152
40	368	156
41	377	160
42	386	164
43	396	168
44	405	172
45	414	176
46	423	180
47	433	184
48	442	187
49	451	191
50	460	195
51	469	199
52	479	203
53	488	207
54	497	211
55	506	215
56	515	219
57	524	223
58	534	226
59	543	230
60	552	234
61	561	238
62	571	242
63	580	246
64	589	250
65	598	254
66	608	258
67	618	262
68	626	266

Min.	23 d.	67 d.
69	635	269
70	644	273
71	653	277
72	663	281
73	672	285
74	681	289
75	690	293
76	699	297
77	709	301
78	718	305
79	727	308
80	736	312
81	746	316
82	755	320
83	764	324
84	773	328
85	782	332
86	792	336
87	801	340
88	810	344
89	819	348
90	828	352
91	838	356
92	847	360
93	856	363
94	865	367
95	874	370
96	884	375
97	893	379
98	902	383
99	911	387
100	920	391
200	1841	781
300	2761	1172

M.	24 d.	66 d.	M.	24 d.	66 d.	Min.	24 d.	66 d.
1	9	4	35	320	142	69	630	281
2	18	8	36	329	146	70	639	285
3	27	12	37	338	151	71	648	289
4	36	16	38	347	155	72	658	293
5	46	20	39	356	159	73	667	297
6	55	24	40	365	163	74	676	301
7	64	28	41	374	167	75	685	305
8	73	32	42	384	171	76	694	309
9	82	37	43	393	175	77	703	313
10	91	41	44	402	179	78	712	317
11	100	45	45	411	183	79	721	321
12	109	49	46	420	187	80	731	325
13	119	53	47	429	191	81	740	329
14	128	57	48	438	195	82	749	333
15	137	61	49	448	199	83	758	337
16	146	65	50	457	203	84	767	341
17	155	69	51	466	207	85	776	345
18	164	73	52	475	211	86	785	349
19	173	77	53	484	216	87	795	353
20	183	81	54	493	220	88	804	357
21	192	85	55	502	224	89	813	362
22	201	90	56	511	228	90	822	366
23	210	94	57	521	232	91	831	370
24	219	98	58	530	236	92	840	374
25	228	102	59	539	240	93	849	378
26	237	106	60	548	244	94	858	382
27	246	110	61	557	248	95	868	386
28	256	113	62	566	252	96	877	390
29	265	117	63	575	256	97	886	395
30	274	122	64	585	260	98	895	399
31	283	126	65	594	264	99	904	403
32	292	130	66	603	268	100	913	407
33	301	134	67	612	272	200	1827	813
34	310	138	68	621	276	300	2740	1220

M.	25 d	65 d.
1	9	4
2	18	8
3	27	13
4	36	17
5	45	21
6	54	25
7	63	30
8	72	34
9	81	38
10	91	42
11	100	47
12	119	51
13	118	55
14	127	59
15	136	63
16	145	68
17	154	72
18	163	76
19	172	80
20	181	84
21	190	89
22	199	93
23	208	97
24	218	101
25	227	106
26	236	110
27	245	114
28	254	118
29	263	123
30	272	127
31	281	131
32	290	135
33	299	140
34	308	144

M.	25 d	65 d.
35	317	140
36	326	152
37	335	156
38	344	161
39	353	165
40	362	169
41	372	173
42	381	178
43	390	182
44	399	186
45	408	190
46	417	195
47	426	199
48	435	203
49	444	207
50	453	211
51	462	216
52	471	220
53	480	224
54	489	228
55	498	232
56	507	237
57	516	241
58	526	245
59	535	250
60	544	254
61	553	258
62	562	262
63	571	267
64	580	271
65	589	275
66	598	279
67	607	283
68	616	288

Min.	25 d.	65 d.
69	625	292
70	634	296
71	643	300
72	652	305
73	662	309
74	671	313
75	680	317
76	689	321
77	698	326
78	707	330
79	716	334
80	725	338
81	734	343
82	743	347
83	752	351
84	761	355
85	770	360
86	779	364
87	788	368
88	797	372
89	807	376
90	816	380
91	825	384
92	834	389
93	843	393
94	852	397
95	861	401
96	870	406
97	879	410
98	888	414
99	897	418
100	906	423
200	1813	845
300	2719	1268

M.	26d.	64d.
1	9	4
2	18	9
3	27	13
4	36	18
5	45	22
6	54	26
7	63	31
8	72	35
9	81	39
10	90	44
11	99	48
12	108	53
13	117	57
14	126	61
15	135	66
16	144	70
17	153	74
18	162	79
19	171	83
20	180	88
21	189	92
22	198	96
23	207	101
24	216	105
25	225	109
26	234	114
27	243	118
28	252	123
29	261	127
30	270	131
31	279	136
32	288	140
33	297	144
34	306	149

M.	26d.	64d.
35	315	153
36	324	158
37	333	162
38	342	166
39	351	171
40	360	175
41	368	179
42	378	184
43	386	188
44	395	193
45	404	197
46	413	202
47	422	206
48	431	210
49	440	214
50	449	219
51	458	223
52	467	228
53	476	232
54	485	237
55	494	241
56	503	245
57	512	250
58	521	254
59	530	258
60	539	263
61	548	267
62	557	272
63	566	276
64	575	280
65	584	285
66	593	289
67	602	294
68	611	298

Min.	26d.	64d.
69	620	302
70	629	307
71	638	311
72	647	316
73	656	320
74	665	324
75	674	329
76	683	333
77	692	338
78	701	342
79	710	346
80	719	351
81	728	355
82	737	359
83	746	364
84	755	368
85	764	372
86	773	377
87	782	381
88	791	385
89	800	390
90	809	394
91	818	399
92	827	403
93	836	407
94	845	412
95	854	416
96	863	421
97	872	425
98	881	429
99	890	434
100	899	438
200	1798	877
300	2696	1315

M.	27 d.	63 d.	M.	27 d.	63 d.	Min.	27 d.	63 d.
1	9	5	35	312	159	69	615	313
2	18	9	36	321	163	70	624	318
3	27	14	37	330	168	71	633	322
4	36	18	38	338	172	72	641	327
5	45	23	39	347	177	73	650	332
6	53	27	40	356	182	74	659	336
7	62	32	41	365	186	75	668	341
8	71	36	42	374	191	76	677	345
9	80	41	43	383	195	77	686	350
10	89	45	44	391	200	78	695	354
11	98	50	45	401	204	79	704	359
12	107	54	46	410	209	80	713	363
13	116	59	47	419	213	81	722	368
14	125	63	48	428	218	82	731	372
15	134	68	49	436	222	83	739	377
16	143	72	50	445	227	84	748	381
17	151	77	51	454	232	85	757	386
18	160	82	52	463	236	86	766	390
19	169	86	53	472	241	87	775	395
20	178	91	54	481	245	88	784	400
21	187	95	55	490	250	89	793	404
22	196	100	56	499	254	90	802	409
23	205	104	57	508	259	91	811	413
24	214	109	58	517	263	92	820	418
25	223	113	59	526	268	93	829	422
26	232	118	60	535	272	94	837	427
27	241	122	61	543	277	95	846	431
28	249	127	62	552	282	96	855	436
29	258	132	63	561	286	97	864	440
30	267	136	64	570	291	98	873	445
31	276	141	65	579	295	99	882	449
32	285	145	66	588	300	100	891	454
33	294	150	67	597	304	200	1782	909
34	303	154	68	606	309	300	2673	1363

M.	28 d.	62 d.
1	9	5
2	18	9
3	26	14
4	35	19
5	44	23
6	53	28
7	62	33
8	71	37
9	79	42
10	88	47
11	97	52
12	106	56
13	115	61
14	124	66
15	132	70
16	141	75
17	150	80
18	159	84
19	168	89
20	177	94
21	185	99
22	194	103
23	203	108
24	212	113
25	221	117
26	230	122
27	238	127
28	247	131
29	256	136
30	265	141
31	274	145
32	282	150
33	291	155
34	300	160

M.	28 d.	62 d.
35	309	164
36	318	169
37	326	174
38	335	178
39	344	183
40	353	188
41	362	192
42	371	197
43	380	202
44	388	207
45	397	211
46	406	216
47	415	221
48	424	225
49	432	230
50	441	235
51	450	239
52	459	244
53	468	249
54	477	254
55	485	258
56	494	263
57	503	268
58	512	272
59	521	277
60	530	282
61	538	286
62	547	291
63	556	296
64	565	300
65	574	305
66	583	310
67	591	315
68	600	319

Min.	28. d.	62 d.
69	609	324
70	618	326
71	627	333
72	636	338
73	644	343
74	653	347
75	662	352
76	671	357
77	680	361
78	689	366
79	697	371
80	706	376
81	715	380
82	724	385
83	733	390
84	742	394
85	750	399
86	759	404
87	768	408
88	777	413
89	786	418
90	795	422
91	803	427
92	812	432
93	821	437
94	830	441
95	839	446
96	848	451
97	856	455
98	865	460
99	874	465
100	883	469
200	1766	939
300	2649	1408

M.	29 d	61 d.
1	9	5
2	17	10
3	26	14
4	35	19
5	44	24
6	52	29
7	61	34
8	70	39
9	79	43
10	87	48
11	96	53
12	105	58
13	114	63
14	122	68
15	131	73
16	140	77
17	149	82
18	157	87
19	166	92
20	175	97
21	184	102
22	192	107
23	201	111
24	210	116
25	219	121
26	227	126
27	236	131
28	245	136
29	254	141
30	262	145
31	271	150
32	280	155
33	289	160
34	297	165

M.	29d.	61 d.
35	306	170
36	315	174
37	324	179
38	332	184
39	341	189
40	350	194
41	359	199
42	367	203
43	376	208
44	385	213
45	394	218
46	402	223
47	411	228
48	420	233
49	429	237
50	437	242
51	446	247
52	455	252
53	464	257
54	472	262
55	481	267
56	490	271
57	499	276
58	507	281
59	516	286
60	525	291
61	534	296
62	542	301
63	551	305
64	560	310
65	569	315
66	577	320
67	586	325
68	595	330

Min.	29. d.	61 d.
69	604	334
70	612	339
71	621	344
72	630	349
73	638	354
74	647	359
75	656	363
76	665	368
77	673	373
78	682	378
79	691	383
80	700	388
81	708	393
82	717	397
83	726	402
84	735	407
85	743	412
86	752	417
87	761	422
88	770	427
89	778	431
90	787	436
91	796	441
92	805	446
93	813	451
94	822	456
95	831	461
96	840	465
97	848	470
98	857	475
99	866	480
100	875	485
200	1749	970
300	2624	1454

M.	30 d	60 d
1	9	5
2	17	10
3	26	15
4	35	20
5	43	25
6	52	30
7	61	35
8	69	40
9	78	45
10	87	50
11	95	55
12	104	60
13	113	65
14	121	70
15	130	75
16	139	80
17	147	85
18	156	90
19	165	95
20	173	100
21	182	105
22	191	110
23	199	115
24	208	120
25	217	125
26	225	130
27	234	135
28	242	140
29	251	145
30	260	150
31	268	155
32	277	160
33	286	165
34	294	170

M.	30 d.	60 d
35	303	175
36	312	180
37	320	185
38	329	190
39	338	195
40	346	200
41	355	205
42	364	210
43	372	215
44	381	220
45	390	225
46	398	230
47	407	235
48	416	240
49	424	245
50	433	250
51	442	255
52	450	260
53	459	265
54	468	270
55	476	275
56	485	280
57	494	285
58	502	290
59	511	295
60	520	300
61	528	305
62	537	310
63	546	315
64	554	320
65	563	325
66	572	330
67	580	335
68	589	340

Min.	30 d.	60 d.
69	598	345
70	606	350
71	615	355
72	623	360
73	632	365
74	641	370
75	649	375
76	658	380
77	667	385
78	676	390
79	684	395
80	693	400
81	702	405
82	710	410
83	719	415
84	727	420
85	736	425
86	745	430
87	753	435
88	762	440
89	771	445
90	779	450
91	788	455
92	797	460
93	806	465
94	814	470
95	823	475
96	832	480
97	840	485
98	849	490
99	857	495
100	866	500
200	1732	1000
300	2598	1500

M.	31 d.	59 d.	M.	31 d.	59 d.	Min.	31 d.	59 d.
1	9	5	35	300	180	69	591	355
2	17	10	36	309	185	70	600	360
3	26	15	37	317	191	71	609	366
4	34	21	38	326	196	72	617	371
5	43	26	39	334	201	73	626	376
6	51	31	40	343	206	74	634	381
7	60	36	41	351	211	75	643	386
8	69	41	42	360	216	76	651	391
9	77	46	43	369	221	77	660	397
10	86	51	44	377	227	78	669	402
11	94	57	45	386	132	79	677	407
12	103	62	46	394	237	80	686	412
13	111	67	47	403	242	81	694	417
14	120	72	48	411	247	82	703	422
15	129	77	49	420	252	83	711	427
16	137	82	50	429	257	84	720	433
17	146	88	51	437	263	85	729	438
18	154	93	52	446	268	86	737	443
19	163	98	53	454	273	87	746	448
20	171	103	54	463	278	88	754	453
21	180	108	55	471	283	89	763	458
22	189	113	56	480	288	90	771	463
23	197	118	57	489	294	91	780	469
24	206	124	58	497	299	92	789	474
25	214	129	59	506	304	93	797	479
26	223	134	60	514	309	94	806	484
27	231	139	61	523	314	95	814	489
28	240	144	62	531	319	96	823	494
29	249	149	63	540	324	97	831	500
30	257	154	64	549	330	98	840	505
31	266	160	65	557	335	99	849	510
32	274	165	66	566	340	100	857	515
33	283	170	67	574	345	200	1714	1030
34	292	175	68	583	350	300	2572	1545

M.	32 d.	58 d.	M.	32 d.	58 d.	Min.	32 d.	58 d.
1	8	5	35	297	185	69	585	366
2	17	11	36	305	191	70	594	371
3	25	16	37	314	196	71	602	376
4	34	11	38	322	201	72	610	381
5	42	26	39	331	207	73	619	387
6	51	32	40	339	212	74	627	392
7	59	37	41	348	217	75	636	397
8	68	42	42	356	223	76	644	403
9	76	48	43	365	228	77	653	408
10	85	53	44	373	233	78	661	413
11	93	58	45	382	238	79	670	419
12	102	64	46	390	244	80	678	424
13	110	69	47	398	249	81	687	429
14	119	74	48	407	254	82	695	434
15	127	79	49	415	260	83	703	440
16	136	85	50	424	265	84	712	445
17	144	90	51	432	270	85	721	450
18	153	95	52	441	275	86	729	456
19	161	101	53	449	281	87	738	461
20	170	106	54	458	286	88	746	466
21	178	111	55	466	291	89	755	472
22	187	117	56	475	297	90	763	477
23	195	122	57	483	302	91	772	482
24	204	127	58	492	307	92	780	487
25	212	132	59	500	313	93	788	493
26	220	138	60	509	318	94	797	498
27	229	143	61	517	323	95	805	509
28	237	148	62	526	329	96	814	503
29	246	153	63	534	334	97	822	514
30	254	159	64	543	339	98	831	519
31	263	164	65	551	344	99	839	524
32	271	170	66	560	350	100	848	530
33	280	175	67	568	355	200	1696	1060
34	288	180	68	577	360	300	2544	1590

M.	33 d	57 d.	M.	33 d.	57. d.	Min.	33 d.	57 d.
1	8	5	35	294	191	69	579	376
2	17	11	36	302	196	70	587	381
3	25	16	37	311	202	71	596	386
4	34	22	38	319	207	72	604	392
5	42	27	39	327	212	73	612	397
6	50	33	40	335	218	74	621	403
7	59	38	41	344	223	75	629	408
8	67	44	42	352	229	76	637	414
9	76	49	43	361	234	77	646	419
10	84	54	44	369	240	78	654	425
11	92	60	45	377	245	79	663	430
12	101	65	46	386	251	80	671	436
13	109	71	47	394	256	81	679	441
14	117	76	48	403	262	82	688	446
15	126	82	49	411	267	83	696	452
16	134	87	50	419	272	84	705	457
17	143	93	51	428	278	85	713	462
18	151	98	52	436	283	86	721	468
19	159	104	53	445	288	87	730	473
20	168	109	54	453	294	88	738	479
21	176	114	55	461	300	89	747	484
22	185	120	56	470	305	90	755	490
23	193	125	57	478	310	91	763	495
24	201	131	58	487	316	92	772	501
25	210	136	59	495	321	93	780	506
26	218	142	60	503	327	94	789	512
27	227	147	61	512	332	95	797	517
28	235	153	62	520	338	96	805	522
29	243	158	63	529	343	97	814	528
30	252	163	64	537	348	98	822	533
31	260	169	65	545	354	99	831	539
32	269	174	66	554	355	100	839	545
33	277	180	67	562	365	200	1677	1089
34	285	185	68	571	370	300	2516	1634

M.	34d	56d.
1	8	6
2	17	11
3	25	17
4	33	22
5	41	28
6	50	34
7	58	39
8	66	45
9	75	50
10	83	56
11	91	61
12	99	67
13	108	73
14	116	78
15	124	84
16	133	89
17	141	95
18	149	101
19	158	106
20	166	112
21	174	117
22	182	123
23	191	129
24	199	134
25	207	140
26	216	145
27	224	151
28	232	157
29	240	162
30	249	168
31	257	173
32	265	179
33	274	184
34	282	190

M.	34d	56d.
35	290	196
36	298	201
37	307	207
38	315	212
39	323	218
40	332	224
41	340	229
42	348	235
43	356	240
44	365	246
45	373	251
46	381	257
47	390	263
48	398	268
49	406	274
50	414	280
51	423	285
52	431	291
53	439	296
54	448	302
55	456	307
56	464	313
57	473	319
58	481	324
59	489	330
60	497	335
61	506	341
62	514	346
63	522	352
64	530	358
65	539	363
66	547	369
67	555	374
68	564	380

Min.	34 d.	56 d.
69	572	386
70	580	391
71	588	397
72	597	403
73	605	408
74	613	414
75	622	419
76	630	425
77	638	431
78	647	436
79	655	442
80	663	447
81	671	453
82	680	458
83	688	464
84	696	470
85	705	475
86	713	481
87	721	486
88	729	492
89	738	498
90	746	503
91	754	509
92	763	514
93	771	520
94	779	526
95	788	531
96	796	537
97	804	542
98	812	546
99	821	554
100	829	559
200	1658	1118
300	2487	1678

M.	35 d.	55 d.	M.	35 d.	55 d.	Min.	35 d.	55 d.
1	8	6	35	286	201	69	565	396
2	17	11	36	295	206	70	573	402
3	25	17	37	303	212	71	582	407
4	33	23	38	311	218	72	590	413
5	41	29	39	319	224	73	598	419
6	49	34	40	328	229	74	606	425
7	57	40	41	336	235	75	615	430
8	66	46	42	344	241	76	623	436
9	74	52	43	352	246	77	631	442
10	82	57	44	360	252	78	639	448
11	90	63	45	368	258	79	647	453
12	98	69	46	377	264	80	655	459
13	106	75	47	385	270	81	664	465
14	115	80	48	393	275	82	672	470
15	123	86	49	401	281	83	680	476
16	131	92	50	410	287	84	688	482
17	139	98	51	418	292	85	696	488
18	147	103	52	426	298	86	705	493
19	156	109	53	434	304	87	713	499
20	164	115	54	442	310	88	721	505
21	172	120	55	451	315	89	729	511
22	180	126	56	459	321	90	737	516
23	188	132	57	467	327	91	746	522
24	196	138	58	475	333	92	754	528
25	205	143	59	483	338	93	762	534
26	213	149	60	491	344	94	770	539
27	221	155	61	500	350	95	778	545
28	229	161	62	508	356	96	786	551
29	237	166	63	516	361	97	795	556
30	246	172	64	524	367	98	803	562
31	254	178	65	533	373	99	811	568
32	262	184	66	541	379	100	819	574
33	270	189	67	549	384	200	1638	1174
34	278	195	68	557	390	300	2458	1721

M.	36 d.	54 d.	M.	36 d.	54 d.	Min.	36 d.	54 d.
1	8	6	35	283	206	69	558	406
2	16	12	36	291	211	70	566	411
3	24	18	37	299	217	71	574	417
4	32	23	38	307	223	72	582	423
5	40	29	39	315	229	73	590	429
6	48	35	40	324	235	74	599	435
7	56	41	41	332	241	75	607	441
8	64	47	42	340	247	76	615	447
9	72	53	43	348	253	77	623	453
10	81	59	44	356	258	78	631	458
11	89	65	45	364	264	79	639	464
12	97	70	46	372	270	80	647	470
13	105	76	47	380	276	81	655	476
14	113	82	48	388	282	82	663	482
15	121	88	49	396	288	83	671	488
16	129	94	50	404	294	84	680	494
17	138	100	51	413	300	85	688	500
18	146	106	52	421	306	86	696	506
19	154	112	53	429	311	87	704	511
20	162	118	54	437	317	88	712	517
21	170	123	55	445	323	89	720	523
22	178	129	56	453	329	90	728	529
23	186	135	57	461	335	91	736	535
24	194	141	58	469	341	92	744	541
25	202	147	59	477	347	93	752	547
26	210	153	60	485	353	94	760	553
27	218	159	61	493	358	95	768	558
28	226	164	62	502	364	96	777	564
29	235	170	63	510	370	97	785	570
30	243	176	64	518	376	98	793	576
31	251	182	65	526	382	99	801	582
32	259	188	66	534	388	100	809	588
33	267	194	67	542	394	200	1618	1176
34	275	200	68	550	400	300	2426	1763

M.	37 d.	53 d.	M.	37 d.	53 d.	Min.	37 d.	53 d.
1	8	6	35	279	210	69	551	415
2	16	12	36	287	216	70	559	421
3	24	18	37	295	222	71	567	427
4	32	24	38	303	228	72	575	433
5	40	30	39	311	234	73	583	439
6	48	36	40	319	241	74	591	445
7	56	42	41	327	247	75	599	451
8	64	48	42	335	253	76	607	457
9	72	54	43	343	259	77	615	463
10	80	60	44	351	265	78	623	469
11	88	65	45	359	271	79	631	475
12	96	72	46	367	277	80	639	481
13	104	78	47	375	283	81	647	487
14	112	84	48	383	289	82	655	493
15	120	90	49	391	295	83	663	500
16	128	96	50	399	301	84	671	506
17	136	102	51	407	307	85	679	512
18	144	108	52	415	313	86	687	518
19	152	114	53	423	319	87	695	524
20	160	120	54	431	325	88	703	530
21	168	126	55	439	331	89	711	536
22	176	132	56	447	337	90	719	542
23	184	138	57	455	343	91	727	548
24	192	144	58	463	349	92	735	554
25	200	150	59	471	355	93	743	560
26	208	156	60	479	361	94	751	566
27	216	162	61	487	367	95	759	572
28	224	168	62	495	373	96	767	578
29	232	174	63	503	379	97	775	584
30	240	180	64	511	385	98	783	590
31	248	189	65	519	391	99	791	596
32	256	192	66	527	397	100	799	602
33	264	198	67	535	403	200	1597	1204
34	271	204	68	543	409	300	2396	1805

M.	38 d.	52 d.	M.	38 d.	52 d.	Min.	38 d.	52 d.
1	8	6	35	276	216	69	544	425
2	16	12	36	284	222	70	552	431
3	24	18	37	292	228	71	559	437
4	31	25	38	299	234	72	567	443
5	39	31	39	307	240	73	575	450
6	47	37	40	315	246	74	583	456
7	55	43	41	323	252	75	591	462
8	63	49	42	331	259	76	599	468
9	71	55	43	339	265	77	607	474
10	79	62	44	347	271	78	615	480
11	87	68	45	355	277	79	622	486
12	95	74	46	362	283	80	630	493
13	102	80	47	370	289	81	638	499
14	110	86	48	378	296	82	646	505
15	118	92	49	386	302	83	654	511
16	126	99	50	394	308	84	662	517
17	134	105	51	402	314	85	670	523
18	142	111	52	410	320	86	678	530
19	150	117	53	418	326	87	686	536
20	158	123	54	426	332	88	693	542
21	166	129	55	433	339	89	701	548
22	173	136	56	441	345	90	709	554
23	181	142	57	449	351	91	717	560
24	189	148	58	457	357	92	725	566
25	197	154	59	465	363	93	733	573
26	205	160	60	473	369	94	741	579
27	213	169	61	481	376	95	749	585
28	221	172	62	489	382	96	756	591
29	229	179	63	496	388	97	764	597
30	236	185	64	504	394	98	772	603
31	244	191	65	512	400	99	780	610
32	252	197	66	520	406	100	788	616
33	260	203	67	528	412	200	1576	1231
34	268	209	68	536	419	300	2364	1847

M.	39 d	51 d	M.	39 d.	51 d	Min.	39 d.	51 d.
1	8	6	35	272	220	69	536	434
2	16	13	36	280	226	70	544	440
3	23	19	37	287	233	71	552	447
4	31	25	38	295	239	72	559	453
5	39	31	39	303	245	73	567	459
6	47	38	40	311	252	74	575	466
7	54	44	41	318	258	75	583	472
8	62	50	42	326	264	76	591	478
9	70	57	43	334	271	77	598	485
10	78	63	44	342	277	78	606	491
11	85	69	45	350	283	79	614	497
12	93	75	46	357	289	80	622	503
13	101	82	47	365	296	81	629	510
14	109	88	48	373	302	82	637	516
15	116	94	49	381	308	83	645	522
16	124	101	50	388	315	84	653	529
17	132	107	51	396	321	85	661	535
18	140	113	52	404	327	86	668	541
19	148	119	53	412	334	87	676	547
20	155	126	54	419	340	88	684	554
21	163	132	55	427	346	89	692	560
22	171	138	56	435	352	90	699	566
23	179	145	57	443	359	91	707	573
24	186	151	58	451	365	92	715	579
25	194	157	59	458	371	93	723	585
26	202	164	60	466	378	94	731	591
27	210	170	61	474	384	95	738	598
28	217	176	62	482	390	96	746	604
29	225	182	63	489	399	97	754	610
30	233	189	64	497	403	98	762	617
31	241	195	65	505	409	99	769	623
32	249	201	66	513	415	100	777	629
33	256	208	67	521	422	200	1554	1259
34	264	214	68	528	428	300	2331	1888

M.	40 d.	50 d.
1	8	6
2	15	13
3	23	19
4	31	26
5	38	32
6	46	38
7	54	45
8	61	51
9	69	58
10	77	64
11	84	71
12	92	77
13	100	83
14	107	90
15	115	96
16	123	103
17	130	109
18	138	116
19	146	122
20	153	129
21	161	135
22	169	141
23	176	148
24	184	154
25	192	161
26	199	167
27	207	173
28	214	180
29	222	186
30	230	193
31	237	199
32	245	206
33	253	212
34	260	219
35	268	225
36	276	231
37	283	238
38	291	244
39	299	251
40	306	257
41	314	263
42	322	270
43	329	276
44	338	283
45	345	289
46	352	296
47	360	302
48	368	309
49	375	315
50	383	321
51	391	328
52	398	334
53	406	341
54	414	347
55	421	353
56	429	360
57	437	366
58	444	373
59	452	379
60	460	386
61	467	392
62	475	399
63	483	405
64	490	411
65	498	418
66	506	424
67	513	431
68	521	437

Min.	40 d.	50 d.
69	529	443
70	536	450
71	544	456
72	552	463
73	559	469
74	567	476
75	574	482
76	582	485
77	590	495
78	597	501
79	605	508
80	613	514
81	620	521
82	628	527
83	636	533
84	643	540
85	651	546
86	659	553
87	666	559
88	674	566
89	682	572
90	689	579
91	697	585
92	705	591
93	712	598
94	720	604
95	727	611
96	735	617
97	743	623
98	751	630
99	758	636
100	766	943
200	1532	1286
300	2298	1928

M.	41 d	49 d.	M.	41 d	49 d.	Min.	41 d.	49 d.
1	8	7	35	264	229	69	521	452
2	15	13	36	272	236	70	528	459
3	23	20	37	279	243	71	536	466
4	30	26	38	287	249	72	543	472
5	38	33	39	294	256	73	551	478
6	45	39	40	302	262	74	558	485
7	53	46	41	309	266	75	566	492
8	60	52	42	317	275	76	574	498
9	68	59	43	324	282	77	581	505
10	75	66	44	330	389	78	589	512
11	83	72	45	339	395	79	596	518
12	91	79	46	347	302	80	604	525
13	98	85	47	354	308	81	611	531
14	106	92	48	362	315	82	619	538
15	113	98	49	369	321	83	626	544
16	121	105	50	377	328	84	634	551
17	128	112	51	385	334	85	641	557
18	136	118	52	392	341	86	649	564
19	143	125	53	400	348	87	656	571
20	151	131	54	407	354	88	664	577
21	159	138	55	415	361	89	671	584
22	166	144	56	422	367	90	679	590
23	174	151	57	430	374	91	687	597
24	181	157	58	438	380	92	694	603
25	189	164	59	445	387	93	702	610
26	196	171	60	453	394	94	709	616
27	204	177	61	460	400	95	717	623
28	211	184	62	468	407	96	724	629
29	219	190	63	475	413	97	732	636
30	226	197	64	483	420	98	739	643
31	234	203	65	490	426	99	747	649
32	241	210	66	498	433	100	755	656
33	249	216	67	506	439	200	1509	1312
34	257	223	68	513	446	300	2264	1968

M.	42 d	48 d
1	7	7
2	15	13
3	22	20
4	30	27
5	37	33
6	44	40
7	52	47
8	59	53
9	67	60
10	74	67
11	82	73
12	89	80
13	97	87
14	104	93
15	111	100
16	119	107
17	126	113
18	134	120
19	141	127
20	149	134
21	156	140
22	163	147
23	171	154
24	178	160
25	186	167
26	193	174
27	201	180
28	208	187
29	215	294
30	223	201
31	230	207
32	238	214
33	245	221
34	253	227

M.	42 d.	48 d
35	260	234
36	267	241
37	275	247
38	282	254
39	290	261
40	297	268
41	304	274
42	312	281
43	319	287
44	327	294
45	334	301
46	342	308
47	349	314
48	357	321
49	364	328
50	372	335
51	379	341
52	386	348
53	394	354
54	401	461
55	409	368
56	416	375
57	423	381
58	431	388
59	438	394
60	446	401
61	453	408
62	461	415
63	468	421
64	475	428
65	483	435
66	490	442
67	498	448
68	505	455

Min.	42 d.	48 d.
69	513	462
70	520	468
71	527	475
72	535	482
73	542	488
74	550	495
75	557	502
76	564	509
77	572	515
78	579	522
79	587	529
80	594	535
81	602	542
82	609	549
83	617	555
84	624	562
85	632	569
86	639	575
87	647	582
88	654	589
89	661	595
90	669	602
91	676	609
92	684	615
93	691	622
94	699	629
95	706	635
96	713	642
97	721	649
98	728	655
99	736	662
100	743	669
200	1486	1338
300	2229	2007

M.	43 d	47 d.	M.	43 d	47 d.	Min.	43 d.	47 d.
1	7	7	35	256	239	69	505	470
2	15	14	36	263	245	70	512	477
3	22	20	37	270	252	71	519	484
4	29	27	38	278	259	72	526	491
5	36	34	39	285	266	73	534	498
6	44	41	40	292	273	74	541	505
7	51	48	41	300	280	75	548	511
8	58	54	42	307	286	76	556	518
9	66	61	43	314	293	77	563	525
10	73	68	44	322	300	78	570	532
11	80	75	45	329	307	79	578	539
12	88	82	46	336	314	80	585	546
13	95	89	47	344	320	81	592	552
14	102	95	48	351	327	82	600	659
15	110	102	49	358	334	83	607	666
16	117	109	50	366	341	84	614	673
17	124	116	51	373	348	85	622	680
18	132	123	52	380	355	86	629	687
19	139	130	53	388	361	87	636	693
20	146	136	54	395	368	88	643	600
21	153	143	55	402	375	89	651	607
22	161	150	56	409	382	90	658	614
23	168	157	57	417	389	91	665	621
24	175	164	58	424	395	92	673	627
25	183	170	59	431	402	93	680	634
26	190	177	60	439	409	94	687	641
27	197	184	61	446	416	95	695	648
28	205	191	62	453	423	96	702	655
29	212	198	63	461	430	97	709	661
30	219	205	64	468	436	98	717	668
31	227	211	65	475	443	99	724	975
32	234	218	66	483	450	100	731	682
33	241	225	67	490	457	200	1463	1364
34	248	232	68	497	464	300	2194	2046

M.	44 d	46 d	M.	44 d.	46 d	Min.	44 d.	46 d.
1	7	7	35	252	243	69	496	479
2	14	14	36	259	250	70	503	486
3	22	21	37	266	257	71	511	493
4	29	28	38	273	264	72	518	500
5	36	35	39	280	271	73	525	507
6	43	42	40	288	278	74	532	514
7	50	49	41	295	285	75	539	521
8	58	56	42	302	292	76	547	528
9	65	62	43	309	299	77	554	535
10	72	69	44	316	306	78	561	542
11	79	76	45	324	313	79	568	549
12	86	83	46	331	320	80	575	556
13	93	90	47	338	327	81	583	563
14	101	197	48	345	334	82	590	570
15	108	104	49	352	340	83	597	577
16	115	111	50	360	347	84	604	584
17	122	118	51	367	354	85	611	590
18	129	125	52	374	361	86	619	597
19	137	132	53	381	368	87	626	604
20	144	139	54	388	375	88	633	611
21	151	146	55	396	382	89	640	618
22	158	153	56	403	389	90	647	625
23	165	160	57	410	396	91	655	632
24	173	167	58	417	403	92	662	639
25	180	174	59	424	410	93	669	646
26	187	181	60	432	417	94	676	653
27	194	188	61	439	424	95	683	660
28	201	295	62	446	431	96	690	667
29	209	201	63	453	438	97	698	674
30	216	208	64	460	445	98	705	681
31	223	215	65	468	452	99	712	688
32	230	222	66	475	458	100	719	695
33	237	229	67	482	465	200	1439	1389
34	245	236	68	489	472	300	2158	2084

M.	45 d.	45 d.	M.	45 d.	45 d.	Min.	45 d.	45 d.
1	7	7	35	247	247	69	488	488
2	14	14	36	254	254	70	495	495
3	21	21	37	261	261	71	502	502
4	28	28	38	268	268	72	509	509
5	35	35	39	275	275	73	516	516
6	42	42	40	283	283	74	523	523
7	49	49	41	290	290	75	530	530
8	56	56	42	297	297	76	537	537
9	64	64	43	304	304	77	544	544
10	71	71	44	311	311	78	551	551
11	78	78	45	318	318	79	558	558
12	85	85	46	325	325	80	566	566
13	92	92	47	332	332	81	573	573
14	99	99	48	339	339	82	580	580
15	106	106	49	346	346	83	587	587
16	113	113	50	353	353	84	594	594
17	120	123	51	360	360	85	601	601
18	127	127	52	367	367	86	608	608
19	134	134	53	375	375	87	615	615
20	141	141	54	382	382	88	622	622
21	148	148	55	389	389	89	629	629
22	155	155	56	396	396	90	636	636
23	163	163	57	403	403	91	643	643
24	170	170	58	410	410	92	650	650
25	177	177	59	417	417	93	657	657
26	184	184	60	424	424	94	665	665
27	191	191	61	431	431	95	672	672
28	198	198	62	438	438	96	678	678
29	205	205	63	445	445	97	686	686
30	212	212	64	452	452	98	693	693
31	219	219	65	459	459	99	700	700
32	226	226	66	466	466	100	707	707
33	233	233	67	474	474	200	1414	1414
34	240	240	68	481	481	300	2121	2121

Now for the form of ſetting down a Reckoning, although he which is accuſtomed to keep it in this manner, may haply by uſe and practice diſcern how to order it in a better way then I can preſently preſcribe or think upon, becauſe he hath occaſion often to conſider it in every particular: yet in the mean time I conceive it will be fit to have a Book in *Folio*, that is, two Leaves to a ſheet of paper, and to keep the left ſide of your Book void, that you may write therein all ſuch Occurrents as you ſhall think requiſite. As namely, the Winds, and the Points of the *Compaſs*, upon which your ſhip lies, and what allowance you make for *Lee-ward* way when you ſail by a wind, the number of Glaſſes or Hours, and how many Knots or Miles in each hour, alſo the Latitudes which you find by obſervation of the Meridian-altitude of the Stars, and what elſe you ſhall think remarkable. But before all this, the title of the Voyage in theſe or the like words.

The Journal of our Voyage intended by Gods aſſiſtance from S. I. *in the latitude of* 32 *deg.* 25 *min. to the Coaſt of* England, *&c.*

The right hand Pages, or the right ſide of your Book throughout, may by lines be divided into 12 Columns, as in the Example following doth appear. In the firſt column may be expreſſed the *day*, in the ſecond, the *month*; or at leaſt once in the top of the page; likewiſe in the ſame ſecond column, being large enough, may be ſet down the Latitudes which you find by the Meridian altitudes of the Sun at ſuch times as you make obſervation. In the third column the courſe (the Lee-ward way, if there be any leeing allowed.) In the 4 the Variation of the Needle. In the 5 (having made allowance for the Variation) ſet down the angle of your Rumb with the Meridian. In the 6. col. ſet down the diſtance in miles run upon that Rumb. In the 7, 8, 9, and 10 col. the Northing, or Southing, Eaſting, or Weſting thereto anſwering, as you ſhall find it by your Table. In the 11 your Latitudes by dead reckoning. And laſtly, in the 12 column you may at ſuch times as you think fitteſt, ſet down your *Longitude* from the place from which you firſt departed, or the difference of Longitude from place to place.

da.	Lat. by observation.	course	Variation.	Deg. fro the mirid	di. in miles	North	South	East	West	Lat. by dead Reckonde.	Longitude.
20	February	N E by E	8deg. west	ne 48d	miles 78	522		579		33.17	
21	Latitude 34 d. 25'	N E by E	8deg west	ne 48c	100	669		743		34.24	
21	34 d. 25			Summe is		1191		1322		34.24	02.38
22		ene poi.	8deg. west	ne 54c	100	588		809		35.56	
					56	329		453			
23	Latitude 37 d. 46	ene no.	8deg west	ne 54c	100	588		809		37.40	
					78	458		631			
24	Latitude 39 d. 36	ene no.	8deg. west	ne 54c	100	588		809		39.28	
					84	494		679			
				Summe is		3045		4190			
		The correction by obser. is				80		110		08	
24	39.36					3125		4300		39.36	11.36
25	February	ene	8deg. west	ne 59½	100	507		861		41.05	
					76	385		655			
26		ene	8deg. west	ne 59½	100	597		861		42.37	
					80	412		586			
27	Latitude 43 d. 55	ene	7½deg west	ne 60d	100	500		866		44.09	
					84	420		728			
				Summe is		2731		4657			
				Correction		140		245		14	
27	L. 43. 55					2591		4412		43 55	21.28
28	February	ene ½e	6deg. west	ne 67d	100	391		921		44.54	
					51	199		469			
29		ene ½e	5deg. west	ne 68d	100	375		927		46.02	
					81	304		751			
1	March	ene ½e	4deg. west	ne 69d	100	358		934		47.02	
					66	237		616			
2	La. 48. 4.	ene ½e	2deg. west	ne 71d	100	326		946		48.00	
					78	254		737			
2	La. 48. 4.			Summe is		2444		6301		48.00	06.38

da	Lat. by observation.	cours.	Variation.	Dep. trō. the Mer.	d. in miles	North.	South.	East	West	Lat by dead R.	Longitude.
3	March	e n e ½ e	0 de. west	ne 73d	100 52	292 152		956 497		48.44	
4		e n e ½ e	2 de East	ne 75d	100 68	259 176		966 657		49.28	
5	Latitude 49.58 d.	e n e ½ e	3 de. East	ne 76c	98	237		951		49.52	
5	la. 49.58			Summe is	1116			4027		49.52	46.52
5	8 Hours	n by e ½ e	4 de. East	ne 21d	18	168		64		50.09	
6		south by e	4 de East	se 7 d.	34		337	41		49.35	
6	16 Hours	n by east	4 de. East	ne 15d	36	348		93		50.10	
7		se by east	4 de. East	se 52d	20		123	158		49.58	
8	Latitude 50 d. 4′	East	4 de. East	se 86d	96		67	958		49.51	
	The current setting by estima.	East nort. east.		ne 67½	60	230		554		50.14	
				Summe is		219		1868			
				Correction			100			10′	
8	l. 50 d. 4					119		1868		50.04	51.43
9		east ½ po. n	6 de East	se 89½d	70		60	700		49.58	
10		east ½ po. n	6 de East	se 89½d	52		41	520		49.54	
10	March			Summe is			101	1220		49.54	54.53
	Here the Lizard bears	N by E			13						

For an example, we may frame a reckoning between the two places before mentioned, namely from *Summers Iſlands* to the *Lizard*, whoſe diſtance in their Rumb we have before ſuppoſed to be 3299 miles, as ſome Charts make it, and conſequently their difference of Longitude 70 deg. I would not be underſtood as if I affirmed it to be ſo much, for I ſuppoſe it is leſſe. I was there indeed about 20 years paſt, and ſurveyed it, and then kept a reckoning both outwards and homewards, but I have loſt thoſe reckonings long ſince, and have forgotten what they were, and in this caſe it matters not; for whether the ſuppoſition be neer the truth or not, it ſerves ſufficiently to exemplifie the rule, that being the end for which it is uſed. But if their diſtance be 3299 ſuch miles as contain only 1000 paces in a mile, the ſame being reckoned in ſuch miles, as we have before-mentioned, namely, in ſuch whereof 60 make a degree of a great Circle, which as we find contain 6120 feet in a mile, their diſtance will be little more than 3695 miles, and conſequently, the difference of Longitude little more than $55\frac{1}{2}$ degrees.

Let us therefore ſuppoſe the difference of Longitude between thoſe two places to be 55 degrees, and their Latitudes to be the ſame as before, namely, of the one 32 deg. 25 min. and of the other 50 degrees. And let the Courſes, Diſtances, and other obſervations from *Summers-Iſlands* to the *Lizard* be ſuch as before is ſhewed.

The firſt entrance in this Journal (which is the 20 day of *February*) is thus to be underſtood; namely, that from the time of ſetting ſail (which we ſuppoſe to be the 19 of *February*) till the 20 day at noon, the Ship lies away, and makes her way good upon the Northeaſt and by E. point of the Compaſs; but the Variation being 8 degrees to the Weſtwards (as in the fourth column appears) the rumb upon which ſhe hath run is from the North to the Eaſtwards only 48 deg. as is expreſſed in the 5th column (it is indeed $48\frac{1}{4}$ deg. but the $\frac{1}{4}$ deg. we omit, as for the other circumſtances not to be regarded) upon this rumb ſhe runs 78 miles, as in the 6 column appears, and anſwerable thereto I find in the table before-going, the Northing to be $52\frac{3}{10}$ miles, and the Eaſting $57\frac{9}{10}$, as here in the ſeventh and ninth column is expreſſed by

by these numbers 522 and 579 (for the first figure towards the right hand signifieth the tenth parts of a mile, the rest miles.) Hence then the Northing being 52 miles, if that be added to the Latitude from which it is reckoned, namely, 32 deg. 25. min. it makes the Latitude here to be 33 deg. 17 min. as in the 11 Column appears. In like sort, the second entrance being the 21 of *February*, sheweth that from the 20 day at noon to the 21, she made her way good upon Northeast and by East point of the Compasse, but the Variation being 8 degrees Westerly, the angle of the Rumb with the true Meridian was from the North to the Eastwards 48 deg. and so sailing 100 miles, the Northing is $69\frac{2}{10}$ miles, and the Easting $74\frac{3}{10}$ miles, so that the Latitude now is 34 deg. 24 min. and the like is to be understood of all the rest.

Touching the Longitude expressed in the last column, although a reckoning may be kept and set down without it, yet it is of very good use; and how to convert the Easting or Westing (that is, the miles expressed in the East and West columns of your Journal) into deg. and min. of Longitude; we will shew afterwards, as also how you may easily correct your course, and give the true course or Rumb, allowing the Variation.

But first to proceed with this Journal, observing the Meridian altitude of the Sun upon the 23 and 24 of *February*, I find that my Latitude upon the 24 is 39 deg. 36. min. whereas by dead reckoning it is but 39 deg. 28 min. so the difference is 8 more Northerly: but being well assured of the Latitude found by Observation, I correct the dead reckoning thereby, which may be done by the Rule of Proportion, saying;

As the Summe of the North column	3125	*Co. ar.* 6. 50515
To the summe of the East column;	4300	3. 63347
So the foresaid increase Northerly	80	1. 90309
To the increase Easterly	110	2. 04171

that is, 11 miles: for the first place towards the right hand is only for the tenth parts of a mile.

The same may also sufficently be found without the Rule of Proportion, by the foregoing *Table*, only for looking there under the Degree upon which I have sailed, namely, under 54 deg.

deg. for 8 miles or 80 tenths of a mile, though I find not the ſame exactly, yet I find one which is neer it, namely 82, and againſt it in the next collateral column 113, which is $11\frac{3}{10}$ miles (being too much by $\frac{3}{10}$ of a mile, becauſe the other is too much by $\frac{2}{10}$) I adde therefore in the North column of the Journal 8 miles, and the Eaſt column 11 miles; and ſo whereas by dead Reckoning, the Northing was but $304\frac{5}{10}$ miles, and Eaſting 419 miles; now having corrected it by obſervation, the Northing is $312\frac{3}{10}$ miles, and Eaſting 430 miles.

In like ſort upon the 27th day, I ſhould by dead reckoning be in the Latitude of 44 deg. 09 min. but by a clear and good obſervation I find my ſelf in the Latitude of 43 deg. 55 min. that is, not ſo much Northerly by 14 min. therefore to correct it I put in the South column 14 miles, or 140 tenths, and ſeeing my courſe was between the North and the Eaſt, and that I find my ſelf to be leſſe to the Northwards, that is, more to the Southwards than my reckoning; therefore in probability I am alſo leſſe to the Eaſtwards, that is more to the Weſtwards, than my reckoning; But to find how much, I look in the foregoing Table for the degree upon which I have ſailed, being from the North part of the Meridian to the Eaſtwards 60 deg. and under 60 deg. I look for 14 miles, or 140 tenths, and againſt it in the column adjoyning I find 243, which I ſet down in my Journal in the Weſt column, and ſo ſubſtracting the firſt from the North column, the other from the Eaſt: I find that whereas by dead Reckoning I ſhould be to the Northwards $273\frac{1}{10}$ miles, and to the *Eaſtwards* $465\frac{7}{10}$. Now having corrected it by obſervation, I find that from the 24 day till this time I have run more Northerly than I was by $259\frac{1}{10}$ miles, and more Eaſterly by $441\frac{2}{10}$ miles.

But if your courſe be neer the Eaſt or Weſt, it may ſuffice to correct it in Latitude only, as in the example of the 8 of *March* appears; for in that caſe you cannot correct Longitude, but from ſome further ground.

If there be any Current, you may note it as is done in that Example following the 8 of *March*.

Now if you would ſet down this reckoning upon the Plain

or

or Common *Sea-chart*: Firſt, if you deſire to expreſſe every dayes account, you may begin for the 20 of *February*, and make a prick in your plot that may be from the place from which you ſet ſail to the Northwards $52\frac{3}{10}$ miles, and to the *Eaſtwards* $57\frac{2}{10}$; and ſo will this point be diſtant from the place of your ſetting ſail 78 miles Northeaſt, and almoſt a quarter of a point *Eaſterly*: then for the 21 day you may make another Prick, which may be from the form to the Northwards $66\frac{9}{10}$ miles, and to the Eaſtwards $74\frac{3}{10}$ miles, and ſo you may proceed with the reſt. And thus you ſhall have a prick on the Plot for every day more exactly ſet down; then could be done after the ordinary way by Courſe and Diſtance, or courſe and Latitude, eſpecially becauſe in lining the Plot, there are not, nor cannot conveniently be drawn any more then the 32 points of the *Compaſs*, to wit, not half points, quarters, or ſingle Degrees.

But if you deſire not to ſet down every days reckoning (which is not neceſſary to be done) you may ſet down every of the Summes, as they are corrected by Obſervation after the ſelf-ſame manner.

Or you may adde together all thoſe ſummes, and ſo the ſumme total of the North column will be 1049 miles, and of the *Eaſt* column 2345 miles, therefore in the meridian of the place from which you depart, you may ſet down to the Northwards of that place 1049 miles, which will fall in the Latitude of 49 deg. 54 min. almoſt, and from thence in that parallel ſet down directly to the *Eaſtwards* 2345 miles, and there make a prick for the place where the Ship then is the tenth of *March*, and ſo is all this reckoning ſet down at once.

If you keep reckoning according to *Mercator*, it will be requiſite ſometimes to ſum up your reckonings paſt, namely, ſo often as you make any notable alteration in your courſe; and ſo this reckoning or any other may be ſet down almoſt as eaſily on *Mercator's chart*; the difference is, that here you muſt often alter your *Scale*, becauſe the deg. of Latitude on this *Chart* are not equal, but grow greater and greater towards the Poles. Now then the diſtance of two places is to be meaſured by that part of the *Meridian*, which is intercepted between the Latitudes of thoſe

two

two places; Or if both places lie in one and the ſame Latitude, their Diſtance is meaſured by a Degree or other leſſer quantity, taken about that Latitude; namely, half above, and half beneath.

Wherefore if you would make a Prick or Traverſe-point in *Mercators-Chart*, anſwering to your reckoning for the firſt day, namely, until the 20 of *February* at noon; it appears by your Journal that Prick muſt be to the Northwards of the place from which you departed $52\frac{2}{10}$ miles, and to the Eaſtwards $57\frac{2}{10}$ miles.

Now inſtead of the *North* or *South* columns, you may more conveniently uſe the laſt column but one, ſhewing in what Latitude every account doth fall; and ſo it appears, that the Prick for the 20 of *February* muſt be in the Latitude of 33 deg. 17 min. Therefore in the Meridian of the *Summers-Iſlands* from which you departed make a prick in the *Latitude* of 33 deg. 17 min. and from that prick ſet down to the Eaſtwards in the ſame Latitude $57\frac{2}{10}$ miles, and where it ends is the Traverſe-point anſwering to the 20 of *February*: the like may be done for the 21 day, and ſo for all the reſt. This 58 miles may be taken in the meridian from the Latitude of 32 deg. 22 min. to the Latitude of 33 deg. 20 min. or otherwiſe you may take the half of it which is 29 miles about the middle between both latitudes, and double it.

But it is ſufficient to ſet down the ſums of every two or three dayes accounts, or ſo often as there is any notable Difference in your Courſe; Thus if you would make a prick in the *Chart*, anſwering to the 21 of *February*, being the firſt ſumme; I ſee by the Journal, that it muſt be in the Latitude of 34 deg. 24 min. and to the Eaſtwards of the place from which I departed $132\frac{2}{10}$ miles. Therefore in the meridian of the place from whence I departed, I make a prick in the Latitude of 34 deg. 24 min. and from that prick I ſet in the ſame Latitude to the *Eaſtwards* $132\frac{2}{10}$ miles, and where it ends is the Traverſe-point anſwering to the 21 of *February*, being the firſt ſum. This 132 miles may be taken in the meridian within, or a little without the two Latitudes, as before, namely, from 32 deg. 20 min. to 34 deg. 32 min.

In like ſort, if you would make a prick for the ſecond ſum, being the 24 of *February*, it there appears that it muſt be in the Latitude

titude of 39 deg. 36 min. and to the Eaſtwards of the Traverſe point laſt before made 430 miles; therefore in the meridian of that Traverſe point I make a prick in the Latitude of 39 deg. 36. min. and from that Prick I ſet to the Eaſtwards in the ſame Latitude 430 miles, and where that ends is the Traverſe-point anſwering to the 24 day, and the like is to be underſtood of all the reſt.

Now this 430 miles may be taken ſeveral ways; for firſt, if I take one Degree about the middle of that part of the meridian, which is intercepted between the Latitudes of the two places (as from 36 deg. 30 min. to 37 deg. 30 min.) and that degree ſeven times taken is 420 miles, then about the middle, namely, 37 d. I take 10 min. more, and ſo I have 430 miles.

In like manner, you may take two deg. or 120 miles, to meaſure it thereby, which may be taken from 36 degrees to 38 deg. and the reſidue about 37 degrees, as before, *&c.*

Or you may take the half of 430 miles, namely, 215 miles, which is 3 deg. 35 min. which muſt be taken as before, about the middle of that part of the meridian which is intercepted between the two Latitudes, and that doubled is 430 miles to be ſet to the Eaſtwards, as before.

And thus may this or any other Reckoning be ſet down without knowledge of the Longitudes, but more aptly and exactly by ſome Longitudes known, for then ſhall you have in the two laſt columns the ſubſtance and principal ſcope of your reckoning; namely, the Latitudes and Longitudes of all places, as you ſail, which may more eaſily and exactly be expreſs'd upon this Chart, then the Eaſterly or Weſterly diſtances; Therefore how this alſo may be done, we will ſhew, but firſt ſomething touching the *Compaſs* and the *Variation* thereof, which ought not to be neglected in a reckoning.

CHAP. X.

Of the Variation of the Compaſſe, and how to rectifie a Courſe by the Variation known.

AMongſt all the myſteries which God hath of late years diſcovered to the World for the furtherance of *Navigation*, there is none more neceſſary, nor yet more admirable then that property of the *Needle* touched with the Load-ſtone, whereby in the vaſt Ocean where all Land-marks fail, yea even in the darkeſt nights and cloſeſt weather, when neither Sun nor Stars are to be ſeen, the Mariner (as it were by a Meſſenger ſent from Heaven) is taught which way to direct his ſhip; yea, as it were accompanied with a guide towards his deſired Port.

For the Needle touched, beſides other ſtrange properties, hath this, to point out in all quarters of the World, the North and South parts of the Horizon, and ſo having a Card thereto fitted with Rumbs and Degrees, it ſheweth all Points of the Compaſſe, and degrees of the Horizon.

Yet very ſeldome exactly of it ſelf, without ſome further Art and Induſtry of him that uſeth it; for though in ſome places it ſwerves not, yet in moſt parts of the World the North and South points of the Needle have ſome *Variation* from the true North and South points of the Horizon to the Eaſtwards or to the Weſtwards, which how to diſcover in kind and quantity, we have ſhewed heretofore.

It may be thought, (and ſome men otherwiſe learned before this Property was fully diſcovered, have ſaid) that this ſhould be ſome blemiſh and imperfection in a ſtone ſo precious; But it is ſo far from being an imperfection, that it makes it ſo much the more precious? Yet (as I have ſaid) not without the induſtry of him that uſeth it. He that is negligent or unskilful to obſerve it, eſpecially in long Voyages and various Courſes, may be led into many dangers by it, becauſe he frames not his mind to the Rule, but the Rule to his mind, imagining it to be what it is not:

and

and hence I ſuppoſe, ſprang that Cuſtome of placing the *Needle* or *Wyars* a point or half a point to the Eaſtwards of the North-point of the Card, thinking by this means to ſhun the labour of obſerving the Variation, which indeed they might, if the Variation were the ſame in all places, and at all times; but becauſe it is not, this doth often encreaſe the Errour.

But he that diligently obſerves the Variation, finds (as I ſay) no prejudice in it, only it requires daily, or once in two or three dayes half an hours work; and this labour it doth abundantly recompenſe; for by this means he knows at the preſent how to direct his Courſe, and for the future, by thoſe notes which he keeps of the *Variations* and *Latitudes* by him obſerved, he knows (coming that way again) when he draws neer to any of thoſe places where ſuch Obſervations were made, and ſo falls the more certainly with any place intended.

There is further diſcovered of late a motion or alteration in the Variation of the *Needle*, and this is ſcarce yet certainly diſcovered. But comparing the Variations which were obſerved about fifty years paſt, with the preſent Variations: It appears they are leſſer Eaſterly, and more Weſterly by 6 or 7 degrees, then they were at that time. For whereas the Variation hath formerly been obſerved neer *London* to be $11\frac{1}{4}$ Deg. to the Eaſtwards, it doth now ſcarce exceed 4 Degrees. And there is the like alteration (as I have heard by ſome Mariners) in other parts of the World; which we now leave to the further diſcovery of time and induſtry, and come to ſhew how to rectifie a Courſe by the Variation known.

The point of the Compaſſe upon which you ſail, and the Variation of the Needle known, to find the Rumb or Degree upon which the Ship hath made her way.

IT is beſt that the *Needle* or *Wyars* be placed directly under the *Flower de luce*, or *North* and *South* points of the *Card*, and ſo in the Rules following we preſuppoſe them to be. Now then it is to be underſtood, that the *Needle* having Variation

(as for the moſt part it hath) the ſhip doth not make her way upon that Rumb or Point of the Compaſs, which ſhe ſeems to ſail upon, but either more to the right hand or to the left, according as the Variation is towards the right hand, or towards the left, and that ſo much towards the one ſide, or towards the other as that Variation is: We ſpeak not here of *Lee-ward way*, but of the Variation only. Therefore for the ſolution of this *Problem* you muſt know how much the Variation is, and which way; And how this may be done, we have briefly ſhewed upon the 12 Caſe of *Right angled ſpherical Triangles*, and the 11 of *Oblique*, which known, you may find the angle of the Rumb or Line of your ſhips way with the *Meridian*: being the thing in this *Probleme* required.

A Table of the Angles of every Point and half Point of the Compaſs with the Meridian.

	North	South	D. M.	North	South
½			00 00		
1	N by E	S by W	05 37 11 15	N by W	S by E
1½			16 52		
2	N N E	S S W	22 30	N N W	S S E
2½			28 07		
3	N E by N	S W by S	33 45	N W by N	S E by S
3½			39 22		
4	N E	S W	45 00	N W	S E
4½			50 37		
5	N E by E	S W by W	56 15	N W by W	S E by E
5½			61 52		
6	E N E	W S W	67 30	W N W	E S E
6½			73 07		
7	E by N	W by S	78 45	W by N	E by S
7½			84 22		
8	East	West	90 00	West	East
	Add East variation Subſtract Weſt.			Add Weſt variation Subſtract Eaſt.	

For

For the effecting whereof, we will ſet down two wayes; the one by the Pen alone, the other inſtrumentally. If you do it by the Pen alone, althongh it be not hard to find what angle every point or half point makes with the Meridian; yet for your further eaſe herein, I have expreſſed the ſame in the Table beforegoing; the quarters of Points I have omitted, becauſe the ſteerage upon a quarter of a point is very uncertain, (the points being undivided as uſually they are) for a man by his eye is able to gueſſe very neerly which is the middle between two points, but he cannot gueſſe ſo neerly which is the fourth part. Yet if you deſire any quarter, you may adde to the next before-going almoſt 3 deg. namely 2 deg. 49 min.

Now then by the magnetical Rumb or Point of the Compaſs and Variation given, to find the true Rumb, you are to obſerve theſe two Rules following.

1. *If the Rumb and the Variation be both the ſame way from the Meridian (namely, both to the right hand, or both to the left) adde them together, and that ſumme is the true Rumb from that part of the Meridian.*

Yet if that ſumme exceed 90 *degrees, ſubſtract it from* 180 *degrees, the remainder is the Rumb from the oppoſite part of the Meridian.*

2. *If the one be towards the right hand, the other towards the left, ſubſtract the variation from the Rumb, and the remainder is the true Rumb.*

Yet if the Rumb be the ſmaller number, ſubſtract it from the Variation, and the remainder is the true Rumb the other way.

Theſe Rules we ſhall endevour to Illuſtrate by examples following.

But firſt for diſtinction ſake, we ſay the Rumbs or degrees from the North towards the Eaſt, are towards the right hand, and ſo from the South towards the Weſt; but from the North to the Weſtwards, on the left hand, and ſo from the South Eaſtwards: For a mans face being towards the North, the Eaſt is on his right hand, and the Weſt on his left, *&c.*

In like ſort for the *variation of the Compaſs*, if it have Eaſterly *variation*, that is, if the *Needle* and *Flower de luce* of the *Card* ſtand

ſtand to the Eaſtwards of the North, we ſay that *Variation* is towards the right hand, for not only the North point but all the other points of the *Compaſſe* direct a Courſe more towards the right hand then they would do, if there were no *Variation*. And ſo if it have Weſterly *Variation*; that is, if the *Needle* and *Flower de luce* ſtand to the Weſtwards of the true North point of the *Horizon*, we ſay that *Variation* is towards the left hand; forasmuch as not only the North-point, but all the other points of the Compaſſe, ſtand more towards the left hand then they would do, if there were no *Variation*: This being premiſed, we come to give *Examples* of the two Rules before-going.

1. Let the Magnetical Rumb or Point of the *Compaſſe* be North-eaſt, and the *Variation* 10 degrees to the Eaſtwards; I demand the true *Rumb*?

Here the *Rumb* and *Variation* are both one way; that is, both towards the right hand; therefore,

To the Magnetical Rumb being N. Eaſterly	45 deg. 0 m.
Add the Variation Eaſterly	10 deg. 0 m.
The ſumme is the true Rumb N. Easterly	55 deg. 0 m.

2. Admit a ſhip ſail upon the North-point of the Compaſſe, and that the Variation be 10 deg. to the Eaſtwards, how doth ſhe make her way?

The magnetical Rumb is North, that is,	00 deg. 0 m.
To which adding the Eaſterly Variation	10 deg. 0 m.
The ſumme is the angle from the North part of the Meridian to the Eaſtwards	10 deg. 0 m.

Which is almoſt *N* by *E*, and ſo hath the ſhip made her way.

3. Let the point of the Compaſſe be East ½ point Northerly, that is, from the North to the Eaſtwards 7½ points, which is 84 deg. 22 min. and the Variation as before 10 deg. to the Eaſtwards, I demand the true Rumb?

To the magnetical Rumb being North-eaſt,	84 deg. 22 m.
Add the Eaſterly Variation	10 deg. 00 m.
The ſumme is the angle from the North	94 deg. 22 m.
Which ſubſtracted from	180 deg. 00 m.
There reſts the true Rumb South-eaſterly	85 deg. 38 m.

4 *Ex-*

4. *Example.* Let the course by the Compasse be West and b South, that is, 7 points from the South to the Westwards, or 78 deg. 45 min. and let the Variation be as before 10 deg. to the Eastwards, what is the true Rumb?

To the Magnetical Rumb *South Westerly*	78 deg. 45 min.
Add the *Easterly Variation*	10 deg 00 min.
The summe is the true Rumb *South westerly*	88 deg. 45 min.

You may conceive that the *Rumb* and *Variation* are here both one way: namely, both from the *Meridian* towards the right hand. For the Variation of the *North* point is from the *North* towards the *East*, and consequently of the *South* point from the *South* towards the *West*, both towards the right hand of the *Meridian*, as the *Rumb* is.

5 *Example.* Let the course by the *Compass* be *West*, that is, from the *South* to the *Westwards* 8 points or 90 degrees, and let the Variation be as before 10 deg. to the *Eastwards*, I would know the true Course or Rumb?

To the Magnetical Rumb South-west	90 deg. 0 min.
Add the Variation *Easterly*	10 deg. 0 min.
The summe is the angle with the *South* part of the *Meridian*	100 deg. 0 min.
Which substracted from	180 deg. 0 min.
There rests the true Rumb *N West*	80 deg. 0 min.

Let the Course by the *Compasse* be *West*, that is, from the *North* to the *Westwards* 8 points or 90 degrees, and let the *Variation* be 10 deg. to the *Westwards*: I demand the true Rumb?

To the Magnetical Rumb *N West*	90 deg. 0 min.
Add the Variation *Westerly*	10 deg. 0 min.
The summe is	100 deg. 0 min.
Which substracted from	180 deg. 0 min.
There remains the true Rumb *S West*	80 deg. 0 min.

Object. The Magnetical Rumb being here west 90 deg. why should it not as well be counted from the *South* as from the *North*?

Answ. It may be counted from either, for as it is counted here from the North to the Westwards it falls under the first *Rule*, because

becauſe the Variation is the ſame way: But if it be reckoned from the South to the Weſtwards, it falls under the ſecond Rule, whereof we now come to give ſome Examples, ſuppoſing theſe already given ſufficient to illuſtrate the firſt Rule?

7 *Example.* Let the point of the Compaſſe be N N W and the Variation 10 deg. Eaſterly, I demand the true Rumb:

From the magnetical Rumb N W	22 deg. 30 m.
Subſtract the Eaſterly Variation	10 deg. 00 m.
The remainder is the true Rumb N W	12 deg. 30 m.

8 *Example.* Let the point of the Compaſſe be North, and the Variation Eaſterly 10 deg. what is the true Rumb?

From the Eaſterly Variation	10 deg. 0 min.
Subſtract the Magnetical Rumb N W.	00 deg. 0 m.
The remainder is the true Rumb, the other way, namely N E	10 deg. 0 min.

Object. The magnetical Rumb may as well be named North eaſterly 0 deg. 0 min.

Anſ. It may, but then it is ſubject to the firſt Rule, as in the ſecond *Example.*

9 *Example.* Let the Courſe by the Compaſs be Weſt, that is, from the North to the Weſtwards 8 points, or 90 degrees, and let the variation be as before 10 degrees to the Eaſtwards, what is the true Rumb?

From the Magnetical Rumb N W.	90 deg. 00 min.
Subſtract the eaſterly variation	10 deg. 00 min.
There reſts the true Rumb N W	80 deg. 00 min.

Here the Magnetical Rumb might as well have been Southweſterly 90 deg. and ſo it had fallen under the firſt Rule, as in the fifth example.

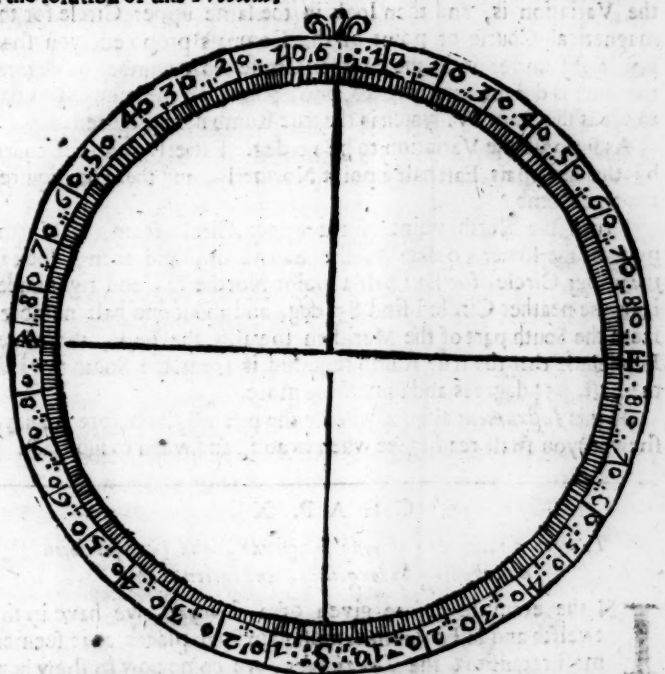
10 *Example.* Let the Courſe by the Compaſs be Weſt; that is, from the South to the Weſtwards, 8 points or 90 degrees, and let the variation be 10 deg. to the weſtwards, I demand the true Rumb?

From the magnetical Rumb S W.	90 deg. 0 min.
Subſtract the weſterly variation	10 deg. 0 min.
The remainder is the true Rumb S W	80 deg. 0 min.

If

If the Rumb here had been reckoned from the North, as in the fixth *Example*, it had fallen under the firſt *Rule*.

And this may ſuffice for the illuſtration of the two former Rules in the ſolution of this *Problem*.



The ſame may alſo more eaſily be reſolved, by ſuch an *Inſtrument* as is here deſcribed, conſiſting of two *Circles*, the one being the nethermoſt divided into four Quadrants, and every of thoſe into 90 deg. numbred from the *North* and *South* points, towards the *Eaſt* and *Weſt*.

The other being the uppermoſt and moveable about the *Centre* divided; as the Card of the Compaſſe into XXXII *Points*, and thoſe again ſub-divided into *halves* and *quarters*.

By this you may readily find the true Rumb for any Courſe and Variation given.

For if you turn the North point of the upper Circle, from the North point of the lower, ſo many deg. and the ſame way that the Variation is, and then look in the ſame upper Circle for the magnetical Courſe or point of the Compaſs propoſed, you ſhall find right under it in the neather Circle what number of degrees the ſame is diſtant from the *N.* or *S.* points of the true Meridian towards the E. or W. which is the true Rumb here required.

As ſuppoſe the Variation to be 10 deg. Eaſterly, and the courſe by the Compaſs Eaſt half a point Northerly, and there be required the true Rumb?

I turn the North point of the upper Circle from the North-point of the lower 10 deg. to the Eaſtwards, and then I look in the upper Circle, for Eaſt half a point Northerly, and right under it in the neather Circle I find 85 deg. and about one half numbred from the South part of the Meridian towards the Eaſt, therefore, I conclude that the true Rumb required is from the South towards the Eaſt, 85½ degrees and ſomething more.

By this *Inſtrument* alſo (if you uſe the pen only, as before we have ſhewed) you ſhall readily ſee when to add, and when to ſubſtract.

CHAP. XI.

To keep a reckoning of your longitude, and ſo to ſet down a reckoning by longitude, and latitude only.

IN the example before given of a *Journal*, we have in the twelfth and laſt column expreſſed in ſuch places as it ſeemed moſt requiſite, the *Longitudes*, we come now to ſhew how the ſame may be known, and firſt,

By the Rumb and Latitudes given to find the Difference of Longitude.

As *Radius* is in proportion, to the Tangent of the Rumb;
So is the Difference of Latitude in meridional parts,
To the Difference of Longitude in minutes.

As let the Rumb be North-eaſterly 48 degrees, and ſuppoſe a Ship to run upon this Rumb, from the Latitude of 32 degrees 25 min.

min. into the Latitude of 34 deg. 24 min. there is required the difference of Longitude. Here,

The meridional parts answering to 34 deg. 24 min.		2200
The meridional parts for	32 25	2058
The difference of latitude in such parts is		142

Say then, As *Radius* is in proportion

To the tangent of the Rumb, 48 d. 0 min.		10.0456
So the difference of latitude in merid. parts	142	2.1523
To the difference of Longitude in minutes	158	2.1979

These minutes converted into deg. are 2 deg. 38 min. which is the difference of Longitude required, as the same is expressed in the Journal against the 21 of *February*.

And thus sailing upon one and the same Rumb, you may find the difference of Longitude, and so often as you alter your Rumb, so often working by the same Rule, you shall have all the differences from place to place, which added together, make the whole difference of Longitude.

But you may also find the Difference of Longitude neer enough at one operation for many several Rumbs and Distances, provided that those Rumbs differ not much one from another. As in the former Journal from the 27 of *February*, till the second of *March*, I sail by several Rumbs and Distances from the Latitude of 43 deg. 55 min. into the Latitude of 48 deg. if you would find the difference of Longitude hereto answerable at one operation, it may be done by this Rule;

As the difference of Longitude in miles,
Is to the departure from the meridian in miles.
So is the difference of Latitude in meridional parts;
To the difference of Longitude in minutes.

As in that example, the difference of Latitude for all those Courses, as in the North column appears is 444.
The departure from the meridian, as there in the East column appears is 6301.
The merid. parts for the latitude of 43 deg. 55 mins. are 2939
The merid. parts for the latitude of 48 deg. 0 m. are 3292
Difference of latitude in meridional parts is 353

Say then, As the difference of Latitude 2444 *co. ar.* 6.6119
To the departure from the Meridian 6301 3.7994
So the difference of Latitude in Merid. parts 353 2.5478
To the difference of Longitude in minutes, 910 2.9591

Which reduced into degrees, is 15 deg. 10 min. And added to the former Longitude 21 deg. 28 min.
Gives the preſent Longitude 36 deg. 38 min. for the 2 of *March*.

The like may be done for the account from the ſecond of *March* to the fifth of the ſame, *&c.*

But if your Courſes and Diſtances run, be all neer to one and the ſame Parallel of Latitude (as in this Journal they are from the 5 of *March* to the 8) and from the 8th to the 10th, then it is ſufficient to find what Longitude in that Parallel is anſwerable to the miles of Eaſting or Weſting, or departure from the Meridian by this Rule.

As the ſine complement of the Latitude of that Parallel,
Is in proportion to *Radius*;
So is the number of miles in that Parallel,
To the difference of Longitude in minutes.

As from the 5 of *March* to the 8. the Latitude was neer 50 deg. the Eaſterly diſtance 186 $\frac{1}{10}$ miles: therefore for the difference of Longitude, ſay:

As ſine complement the Latitude, *s. c.* 50 deg. 0 min. 1919
To *Radius*,
So is the departure from the Meridian 186 8 3.2714
To the difference of Longitude 290 6 3.4633

Thus it appears, the difference of Longitude is almoſt 291 minutes, which is 4 deg. 51 min. and this added to the Longitude upon the 5th of *March*, namely, to 46 deg. 52 min. the ſum is 51 deg. 43 min. the Longitude upon the 8th of *March*: the like might be done for the 10th of *March*.

And though this laſt Rule be then fitteſt to be uſed, when your Courſe is neat Eaſt and Weſt, or your difference of Latitude little; yet it may alſo be uſed at other times inſtead of the two former, without any great errour, if you take the middle degree of Latitude, or ſomewhat more, as in the former Example.

The

The Latitude upon the 27 of *February* is 43 deg. 55 min.
The Latitude upon the second of *March* is 48 deg. 0 min.
The middle Latitude or somewhat more is 46 deg. 10 min.
Say then, As sine comp. the latitude *s. c.* 46 deg. 10 m. 1595
To *Radius*,
So the Easting or departure from the meridian 630. 1. 3. 7994
To the difference of Longitude, 909. 7. 3. 9589
Which is almost 910 min. or 15 deg. 10 m. as before.

And thus you may in the 12th and last column of your Journal, set down your longitude so often as you think is requisite; and so in the two last columns you shall have the substance and principal scope of your Reckoning, namely, your latitudes and longitudes, which whensoever you desire to set down in *Mercators Chart*, or in the *polar Chart*, or in any other, graduated with degrees of longitude and latitude, you may readily do it.

As if I would set down the summe of the foresaid *Journal* from the 19 of *February* to the 10 of *March*, I find against the 10th of *March* the latitude to be 49 deg. 54 min. and the difference of longitude 54 deg. 53 min. Therefore in the latitude of 49 deg. 54 min. I draw an occult parallel, and reckoning from the *Summers-Islands* towards the East 54 deg. 53 min. I draw by that longitude an occult meridian, the Intersection of this meridian with the foresaid Parallel is the Traverse-point, or the point representing the place of the Ship, and the like is to be understood of any other.

This form of keeping and expressing a Reckoning, is (as I conceive) most apt and agreeable (of all others that I have seen or thought upon) to all sorts of *Charts* or *Maps*, and to the *Globe* it self; and to all the kinds or wayes of Sailing, that are or may be used. We will here add some other Propositions which may sometimes be of good and necessary use in it.

The Rumb and Difference of Latitude given: to find by the Table, the Distance in the Rumb, and the Departure from the Meridian thereto answerable, &c.

HOw to find the Northing or Southing, that is, the Distance in latitude; as also the Easting or Westing, that is, the Distance

ſtance in Longitude or departure from the Meridian of any Rumb, for any diſtance run upon it we have before ſhewed, the like operation is in theſe Propoſitions following: namely,

2 *The Rumb and diſtance in latitude given: to find the diſtance in the Rumb, and the Eaſting or Weſting.*

3 *The diſtance and difference in latitude given: to find the departure from the Meridian and the Rumb.*

4 *The difference in latitude, and departure from the Meridian given: to find the Courſe and Diſtance.*

5 *The Courſe and Departure from the Meridian given: to find the Difference of Latitude and Diſtance.*

6 *The Diſtance and Departure from the Meridian given: to find the Courſe and difference of latitude.*

So that with the firſt before-handled, here are ſix Propoſitions, and in every of them two things required; and ſo they become twelve. We will not ſtand to give examples of them all, but only of thoſe which are moſt uſeful, the reſt may by them be conceived.

And firſt, to find the Eaſting or Weſting of any *Rumb* for any difference of Latitude.

Admit a Ship run North-eaſterly 60 deg. (that is, N E by E, and almoſt half point eaſterly) till ſhe have altered the latitude 42 min. how much is ſhe departed from the meridian?

I run down the column under 60 deg. till I find 42 miles, or 420 tenths, and againſt it in the adjacent column I find 728 tenths, that is almoſt 73 miles, which is the departure from the meridian to the Eaſtwards.

If you would alſo have the Diſtance upon the Rumb, it is right againſt theſe numbers in the column of Diſtances, being in this Example 84 miles.

2. *Example.* But admit ſhe run North eaſterly 60 deg. till ſhe alter her latitude 1 deg. 32 min. what is the eaſterly Diſtance?

This 1 deg. 32 min. is 92 miles, or 920 tenths, for which if I look in the column under 60 deg. I find no number ſo great, but the greateſt number there is 500, which ſubſtracted from 920, there remains 420, therefore in that column under 60 d.

100	500	866
84	420	728
184	920	1594

I

I look for these two numbers, namely, 500, and 420, and against the first in the adjacent column I find 86, and against the second 728, which I set against them as above appeareth, and so adding them, I find for this difference of Latitude, the departure from the meridian to be 159$\frac{4}{10}$ miles.

If further you desire the Distance run upon this Rumb, you have it in the column of Distances, right against the same numbers, as in the example above appeareth, where being added, it amounts to 184 miles.

The Distance and difference in Latitude given: to find the Rumb and departure from the Meridian.

ADmit a ship run upon some Rumb between the North and the East 84 miles, and then have altered her Latitude 42 m. the question is, upon what Rumb hath she run, and how many miles is she to the Eastwards in Longitude.

I run cross the Table towards the right hand, looking in every first column of Distances for 84, till I find against it in one of the adjacent columns 420, at the top of which column over 420, there is 60 deg. shewing the Rumb to be North-easterly 60 deg. also against 420 in the adjacent column I find 728, which sheweth the Distance to the eastwards to be almost 73 miles.

2 *Example.* But if the Distance run be 184 miles, and the difference of latitude 1 deg. 32 min. and there be required the Rumb and Distance to the Eastwards?

Because the Column of Distances extends but to 100 miles, and and the Distance here given 184 miles, you may take the half thereof, which is 92 miles, and likewise the half of 1 deg. 32 min. which is 46 miles, or 460 tenths, and then look, as before, where you find 460 against 92, for there in the top of the column you shall find the Rumb, which in this example is 60 deg. shewing that the Rumb is from the North Easterly 60 deg. and in the adjacent column against 92 and 460, you shall find 797, which doubled (because it is for the half) is 1594, shewing that the departure from the meridian to the Eastwards is 159$\frac{4}{10}$ miles. These and the rest may also be performed by the *Doctrine of plain Triangles*, as we have formerly shewed.

CHAP.

CHAP. XII.

Certain Problems touching Currents.

ALthough the time be already expired which I aſſigned for this Work, and mine own more urgent occaſions call me away, yet ſeeing it is neceſſary in Navigation to take notice of Currents and to make a competent allowance for them: I will briefly ſet down certain *Ploblems*, ſuch as I have ſometimes thought upon, whereby a man may the better conceive and judge of that allowance, the rather for that I know not any that hath handled it.

Firſt then, it is to be conceived, that a Ship or other Veſſel ſailing or rowing where there is a Current hath a compound motion ariſing of two different Principles; namely, of the Current and Ships way, ſo that here are three Motions to be conſidered, namely, two ſimple, and the third compounded of them. The firſt ſimple motion is that of the Current, whereby it moveth, and is apt to move other things that are in it, the ſame way. The ſecond of the Ship or Boat, as it moveth by wind or oares, or is apt to be moved, if there were no Current: The third, compounded of them, is the line of the Ships true Motion. The firſt, we call the way, or motion of the Current: the ſecond, the way or ſimple motion of the Ship: the third, her compound or true way. The two ſimple Motions being either of them according to right lines and uniform (as in the *Problems* following, we ſuppoſe them to be.) The third alſo, which is compoſed of them is a right line; For whether the Ship ſail directly oppoſite againſt the Current, or directly with it the ſame way, or whether the one croſſe the other at right angles or at oblique, yet ſtill either motion being direct and uniform, they both together beget a right lined uniform Motion, becauſe the one retaineth to the other one and the ſame proportion in every point. And according to theſe grounds we proceed in the Problems following, to determine the proportions of every of theſe Motions, and the angles which they make one with another.

1 *Admit a Current run East 3 miles an hour, and that a ſhip under ſail run West directly againſt it 6 miles an hour in her ſimple motion, what is her true or compound motion?*

From the ſhips ſimple motion	6 miles
Subſtract the Current	3 miles
The remainder is the ſhips true motion	3 miles

So the ſhips true way is to the weſtwards 3 miles an hour.

2 *Admit a Current run West 6 miles an hour, and that a ſhip under ſail run directly againſt it, 5 miles an hour by the Log: what is the ſhips compound motion, and which way.*

From the Current being the greater	6 miles
Subſtract the ſhips ſimple motion	5 miles
The remainder is the ſhips true motion	1 mile

Which 1 mile ſhews, that the ſhip by her compound motion falls a ſtern, that is, moves to the weſtwards 1 mile an hour.

In the Experimental practice of the two former *Problems*, it may ſeem that a ſhip or Boat ſo ordered, hath alſo a motion to the right hand, or to the left, but this comes to paſſe, becauſe it is hard, and in a manner impoſſible to ſtemme a Tide or Stream ſo exactly, but that the ſhip will ſwerve, (or yaw as they ſay) either to the one ſide, or to the other.

3 *Admit a Current run East 3 miles an hour, and that the ſhip alſo run East 3 miles an hour by the Log, what is the ſhips true motion?*

To the ſhips ſimple motion	3 miles
Add the Current	3 miles
The ſumme is the ſhips true motion	6 miles

So the ſhips compound or true way is East 6 miles an hour.

4 *Admit a Current run East two miles an hour, and the ſhip South 6 miles an hour; what is the ſhips true motion, and which way?*

In handling of any Art, to avoid circumlocution, there are uſed terms or words of Art, ſerving to expreſſe briefly the things handled. And foraſmuch as this ſubject hath not been formerly handled, nor the Principles or Grounds thereof laid (ſo far as I know) we will add a few ſuch terms as may ſeem moſt neceſſary, expreſſing here what we mean by them.

Let the line A B run from A to the Southwards, and B D from B to the Eastwards, and let A B be in proportion to B D, as 6 to 2, or 3 to 1.

Then doth A B represent the line of the ships simple motion, B D the motion of the Current, and A D the compound motion of the Ship.

And D A B is the angle contained between the line of the Ships simple motion, and the line of her compound or true motion, which for brevities sake we will henceforth call the *Angle of Deflection.* Also A D B is the angle contained between the line of the Ships compound motion, and the set or drift of the Current which we will call *the angle of Reflection.*

Lastly, A B D is the angle contained between the line of the Ships simple motion, and the set of the Current, which we will call *the angle of Incidence.*

Then for the Rumb, the Proportion is thus:

As the simple motion	A B 6 miles	*co. ar.*	9.2219
Is to the Current	B D 2 miles		0.3011
So is *Radius*			
To the tangent of Deflection ∠ D A B	18 deg. 26 min.		9.5230

So the Rumb upon which the Ship makes her way good is South 18 deg. 26 min. Easterly, that is, *S S E* 4 degrees 4 minutes southerly.

2. *For the ships true way, or compound motion.*

As the sine of the Deflection ∠ *D A B*	18 deg. 26 min.		0.5000
To the Current	D B 2 miles		0.3011
So *Radius*			
To the true motion	A D $6\frac{32}{100}$		0.8011

So the ships compound motion is $6\frac{32}{100}$ miles hourly, that is, $6\frac{1}{3}$ miles almost.

5 *A ship sails West five dayes together by the Log 725 miles, but there is a Current, all this while setting to the Southwards $1\frac{1}{4}$ mile an hour: I demand how she hath sailed, and how far?*

The Current setting $1\frac{1}{4}$ mile an hour, sets in 5 dayes 180 miles:

Therefore, As

As the ſimple motion.	A B 725 miles	7.1397
Is to the Current	D B 180 miles	2.2553
So is *Radius*,		
To the tangent of Deflection	ſ D A B 13 d. 57 m.	9.3950

For the Diſtance.

As ſine compl. the Deflection	ſ c D A B 13 d. 57 m.	0.0130
Is to the ſimple motion A B	725 min.	2.8603
So is *Radius*		
To the compound motion A D, 747 miles.		2.8733

So the ſhips true Way is Weſt ſoutherly 13 deg. 57 min. or South-weſterly 76 deg. 3 min. 747 miles.

6 *A ſhip ſails Weſt five dayes together by the Log 725 miles, in a Current ſetting to the Southwards, and then finds that he hath altered his Latitude 3 degrees; I demand the motion of the Current, the true Rumb, and true way of the ſhip?*

This Queſtion differeth little from the former, for ſeeing the difference of Latitude is 3 deg. the motion of the Current is 180 miles: ſo there is given the ſhips ſimple motion, and the motion of the Current, as before, *&c.*

7 *A ſhip in 6 Hours ſails from a certain* Cape *or Head-land South 30 miles by the Log, in a Current ſetting Eaſterly, and then obſerving the ſame Cape, he finds that it bears N N W; I demand how faſt that Current ſets, and how far he hath ſailed?*

As let a ſhip ſail from A towards B South 30 miles, but by means of the Current, ſhe is driven more Eaſterly, namely to D, from whence ſetting the Cape A, it is found to bear *N N W.* And ſeeing the Current ſets from B towards D Eaſterly; therefore the angle of Reflection B D A is 6 points, that is, 67 deg. 30 min. Here then is demanded the diſtance A D, and the drift of the Current in that time B D.

As the ſine of the angle of Reflection	ſ B D A 67 d. 30 m.	.0344
To the ſimple motion of the ſhip A B	30 miles	1.4771
So the ſine of the angle of Deflection	ſ D A B 22 d. 30 min.	9.5736
To the motion of the Current B D	12, $\frac{15}{100}$	1.0851

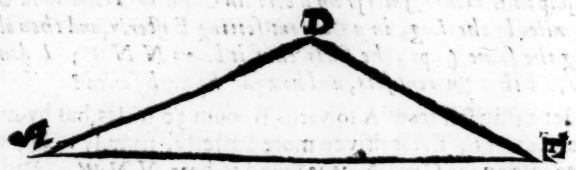
And further,

As the sine of the angle of Reflection *B D A* 67 d. 30 m. 0344
To the distance run by the Log *A B* 30 miles, 1.4771
So is *Radius*
To the compound motion of the ship *A D*, $32\frac{47}{100}$ 1.5115

And thus we find that Current to set $12\frac{16}{100}$; that is, near $12\frac{1}{6}$ miles in 6 hours, and the distance run to be $32\frac{1}{2}$ miles almost.

That the thing may be better conceived, we will use two or three Examples more familiar and obvious to every mans experience; yet grounded upon the same Principles and Reasons.

8. *Admit that* Tulis-stairs *near from* Billingsgate-stairs *S. W. Southerly, namely, South-westerly* 40 *degrees, and be distant* 80 *Poles: and suppose the tide of Ebbe to run there Eastward* $2\frac{1}{2}$ *miles an hour, and that a pair of Oares, rowing* $4\frac{1}{2}$ *miles an hour, would go straight over from the first to the second: how shall they row over, namely, upon what degree or point of the Compasse, and how far shall they row to get thither, and in what time?*



Let A represent *Billinsgate-stairs*, D *Tulis-stairs*, *A E* the simple motion of the Boat, *E D* the motion of the Current, then is A the angle of Deflection, *E* the angle of Incidence; *D* the angle of Reflection 130 deg. or 50 degrees.

As the simple motion of the Boat *A E* $4\frac{1}{2}$ miles 9.34679
Is to the motion of the tide *D E* $2\frac{1}{2}$ miles 0.39794
So the sine of Reflection *D* s 50 deg. 9.88425
To the sine of Deflection *A* s 23 d. 3 m. 9.62898

Thus then the position, from *A* to *D*, being South-westerly 40 deg.

deg. and the angle of Deflection *A* 23 deg. 3. min. the position from *A* towards *E*, is South-westerly 63 degr. 3. min. that is, *W S W* Southerly. And so must those Oares row to go straight over.

Secondly, for the distance A E.

From the angle of Reflection	D	50 deg. 00 min.
Substract the angle of Deflection	A	23 deg. 03 min.
And there rests the angle of Incidence	E	26 deg. 57 min.

As the sine of Incidence *s* E 26 d. 57 m.	0.34370
Is to the true distance *A D* 80 poles	1 90309
So the sine of Reflection *s D* 50 deg. 0 min.	9.88425
To the simple motion *A E* $135\frac{3}{10}$ poles	2.13104

Lastly, for the time, seeing 320 Poles make a mile, and they row, $4\frac{1}{2}$ miles an hour, it is 1440 Poles in an hour: so the proportion is,

As the simple hourly motion	1440	6.8416
To the simple motion before found	$135\frac{3}{10}$	2.1310
So is an hour in minutes, namely,	60 min.	1.7781
To the time required in minutes	$5\frac{61}{100}$	0.7507

And so long will they be rowing.

9 *But suppose they will row harder, to go a shorter cut; namely, to go South-West by West, how fast must they go to row straight over, and how far, and in what time?*

Then seeing the Position from *A* to *D* is South-westerly 40 deg. and *S W* by *W* is South-westerly 56 deg. 15 min. therefore the angle of Deflection at *A* is 16 deg. 15 min. the angle of Reflection *D* as before, 50 *deg.* 0 min. the angle of Incidence *E* is 33 deg. 45 min.

As the sine of Deflection *s* A 16 deg. 15 min.	55311
To the motion of the tide *D E* $2\frac{1}{3}$ miles	0.39794
To the sine of the angle of Reflection *D* 50 deg. 0 min.	9.88425
To the simple hourly motion of the Boat *A E* $6\frac{344}{1000}$	0.85430

And such is the hourly motion of the Boat, namely. $6\frac{344}{1000}$ miles in an hour.

Secondly,

Secondly, for the ſimple motion.

As the ſine of Incidence	*s* E 33 d 45 m.	0.25526
Is to the true diſtance	A D 80 poles	1.90309
So the ſine of Reflection	D 50 deg. 0 min.	988425
To the ſimple motion	A E 110$\frac{3}{10}$ poles	2.04260

Thus it appears they muſt row 110$\frac{3}{10}$ poles to get over.

Laſtly, for the time.

The hourly motion before found	6$\frac{844}{1000}$ reduced into Poles, is	2190$\frac{1}{10}$
As the ſimple hourly motion	2190	6.65956
Is in proportion to an hour, or	60 min.	1.77815
So is the ſimple motion before found	110$\frac{3}{10}$	2.04260
To the time required	3$\frac{033}{1000}$ min.	0.48031

And ſo long will they be rowing over.

10 *But admit a Sculler rowing three miles an hour, would croſſe ſtraight over at the ſame time, upon what point muſt he row, and how far to get thither, and in what time will he do it?*

Firſt, for the angle of Poſition.

As the hourly motion of the Boat	A E 3 miles	9.52288
To the ſine of Reflection	D *s* 50 deg.	9.88425
So is the hourly motion of the ſtream	D E 2$\frac{1}{3}$ min.	0.39794
To the ſine of Deflection	A *s* 39 deg. 40 m.	9.80507

Now ſeeing the poſition for *Billinſgate* to *Tulis ſtairs*, namely from A to D, is by ſuppoſition to the Weſtwards of the South 40 deg. and the angle of Deflection A is here found to be 39 deg. 40 min. therefore the poſition from A to E is from the South to the Weſtwards 79 deg. 40 m. which is Weſt and by South, and almoſt 1 deg. Weſterly, and ſo muſt that *Sculler* row to go ſtraight over.

Secondly, for the diſtance A E.

From the angle of Reflection	D	50 deg. 00 min.
Subſtracting the angle of Deflection	A	39 deg. 40 min.
There reſts the angle of Incidence	E	10 deg. 20 min.

As the ſine of Incidence	*s* E 10 deg. 20 min.	.74624
To the true diſtance	A D 80 poles	1.90309
So is the ſine of Reflection	*s* D 50 deg. 0 min.	9.88425
To the ſimple motion	A E 341$\frac{6}{10}$ p.	2.53358

And

And thus it appears, that though the distance of the two places be but 80 Poles, yet if according to the question, he row but after three miles an hour, and the stream set after $2\frac{1}{2}$ miles an hour, then he must row $341\frac{6}{10}$ poles to go straight over.

Lastly, for the time.

Three miles is 960 Poles, say then

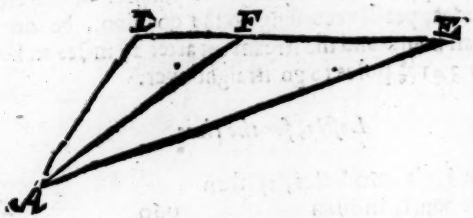
As the simple hourly motion	960	7.01773
To the simple motion before found	$341\frac{6}{10}$	2.53358
So is an hour in minutes, namely,	60 min.	1.77815
To the time required in minutes	$21\frac{35}{100}$	1.32946

And thus it appears that the time requisite to row over, rowing 3 miles an hour; is $21\frac{35}{100}$ minutes, whereas we found before, that rowing there $4\frac{1}{2}$ miles an hour, they might row over in $5\frac{61}{100}$ minutes, which is little more then a fourth part of the time.

There might be other and that great variety of Questions of this nature proposed and resolved, many of good use in practice, which the Water-men by daily experience without other Rules, are able to guesse at something neerly, sufficing for their occasions: my intent in these is especially to explicate the Compound motion of a Ship, or other Vessel sailing or rowing where there is a Current; which by such familiar Examples may seem more evident. I cannot insist upon them by reason of mine other occasions, nor spend that time in these here handled, which else I should have done; whence if any defect or mistake should arise, if the Reader be pleased to give me friendly notice of it, I shall as thankfully accept it, and reform it. We propose next a question at Sea, which let be this.

11 *There is a Current at Sea setting East* 12 *miles in* 24 *hours, a ship sails in the same from a certain Port West South-west* 6 *days, and then returning thence, and sailing N E by North* 3 *dayes, falls with the Port from whence he first departed, I demand what his dead Reckoning was outwards, and what back again, and how far these two Ports were asunder, and upon what point of the Compass?*

As



As let the Current ſet from E towards D, and let the firſt Port be A, the ſecond F, and let the Courſe outward bound be repreſented by A E, and the Courſe homewards by D A, *&c.*

And foraſmuch as D E is an Eaſt and Weſt line, and A E weſt-ſouthweſt, therefore the angle at E is 22 deg. 30 min. and by the like reaſon, the angle at *D* is 123 deg. 45 min. or 56 deg. 15 min. and the angle at A 33 deg. 45 min. and *E D* being the ſetting of the Current for 9 dayes, is 108 miles.

Firſt then, for the dead Reckoning outward, namely A E.

As the ſine of the angle at *A*	ſ 33 deg. 45 min.	.25526
To the line *D E*	108 miles	2.03342
So is the ſine of the angle at *D*	ſ 56 deg. 15 min.	9.91985
To the line *A E*	$161\frac{6}{10}$	2.20853

Thus *A E* his dead Reckoning outwards is $161\frac{6}{10}$

Secondly, for A D.

As the ſine of the angle *D A E*	ſ 33 deg. 45 min.	.25526
Is to the line *D E*	108 miles	2.03342
So is the ſine of the angle *D E A*	ſ 22 deg. 30 min.	9.58084
To the line *A D*	$74\frac{4}{10}$ miles	1.87152

Which $74\frac{4}{10}$ miles is his dead Reckoning homewards.

Thirdly, for the angle D A F or D F A.

The ſide *A D* is found	$74\frac{4}{10}$ miles.
The ſide *D F* for 3 dayes, is	36 miles.
The ſumme of both is	$110\frac{4}{10}$
Their Difference is	$38\frac{4}{10}$
The ſumme of the angles *D A F* and *D F A*	56 deg. 15 m.
The half ſumme is	28 deg. $7\frac{1}{2}$ m.

The

The Proportion.

As the ſumme of the ſides	110 $\frac{4}{5}$	7. 95703
Is to their difference	38 $\frac{4}{5}$	1. 58433
So is the tangent of	28 deg. 07 $\frac{1}{2}$	9. 72706
To the tangent of	10 deg. 32 m.	9. 26932

Which added together, make the angle D F A 38 deg. 39 $\frac{1}{2}$.

And ſeeing the Rumb from F to D is Eaſt, and the angle D F A 38 deg. 39 m. $\frac{1}{2}$, therefore the rumb from F to A is to the Northwards of the Eaſt 38 deg. 39 m. $\frac{1}{2}$, that is N E by E almoſt half a point Northerly, which is the rumb from the ſecond port to the firſt.

Laſtly, for A F, *the diſtance of theſe two ports.*

As the ſine of the angle D F A, s 38 deg. 39 $\frac{1}{2}$		.20434
To the dead reckoning homewards	A D 74 $\frac{4}{10}$ miles.	1.87152
So is the ſine of the angle D s 56 deg. 15 m.		9.91985
To the diſtance	A F 99 $\frac{02}{100}$ miles	1.99571

Thus the true diſtance of thoſe two ports is 99 miles, and ſomewhat more.

Sundry other queſtions of like nature might be propoſed, which to him that well underſtandeth, theſe will not be difficult.

Theſe Principles a little inlarged may further with a few Experiments be applied in the diſcovery of ſome myſteries in compound motions not yet divulged; though much endevoured by ſundry famous men in ſeveral parts of *Europe*, but theſe we ſhall not touch at preſent.

12 *To find where there is a Current at Sea, alſo which way it ſets, and how faſt.*

THis may be done by comparing the reckoning outwards with the reckoning homewards, whereof we will give an Example or two.

Firſt, admit a ſhip ſail from a certain Port, by one or ſeveral Rumbs or Diſtances, till ſhe arrive at a ſecond, and there find reckoning by Courſe and Diſtance, that ſhe is more Southerly than the Port from which ſhe departed by 541 miles, and more Weſterly by 145 miles: But by his Reckoning homewards,

when he arrives again at the first place, he finds himself to the Northwards of the second 541 miles, as before, and to the Eastwards 305 miles. Now supposing he were three dayes outwards bound, and five dayes homewards bound, I would know which way the Current sets, and how fast? Here because the Easterly distance homewards is greater then the westerly distance outwards; therefore from the Easterly distance 305 miles, substract the westerly distance 145 miles, the remainder being 160 miles, is the motion of the Current to the Westwards.

And thus it appears, that that Current sets to the westwards, 160 miles in eight dayes, that is, 20 miles a day, or $\frac{1}{6}$ of a mile every hour.

2. *Example.* Admit a ship sail from the *Summer-Islands*, by several Rumbs and Distances, till she arrive at Cape *Codd* in *New-England*, namely, from the East part of the *Summer-Islands* (the Variation being allowed) first, North 20 miles, and then N N W 150 miles, the second day N by W 180 miles: the third day North 90 miles, the fourth day N East 88 miles, and so arrive at Cape *Codd*: then by these Courses and Distances we may gather by the fore-going Table, that Cape *Codd* should by this Reckoning be to the Northwards 487 miles: and to the Westwards 30 miles, as here appears.

	North	*South*	*East*	*West*
North 20 miles	20 0			
North N W 150 miles	138 6	——	——	57. 4
North by W 180 miles	176 5	——	——	35. 1
North 90 miles	90 0			
Northeast 88 miles	62 2	——	62 2	
528 miles	487 3		62 2	92. 5
				62. 2
				30. 3

Now suppose she sail back again from Cape *Codd* towards the *Summer-Islands*, the first day S S W 150 miles; the second day S S W 160 miles; the third day S by W 130 miles; the fourth day South 140 miles; the fifth day East 110 miles, and so be come again to the East part of the *Summer-Islands*.

South

	North	South	East	West
South S W 150 miles	——	138. 6	——	57. 4
South S W 160 miles	——	147. 8	——	61. 3
South by W 130 miles	——	127. 5	——	25. 3
South 140 miles	——	140. 0	——	
East 110 miles	——	——	110. 0	——
690 miles.		554. 0	110. 0	144. 0
				110. 0
				34. 0

These Courses and Distances make, as here appeareth, the *Summer-Islands* to be to the Southwards of Cape 554 miles, and to the Westwards 30 miles.

Therefore by this last Reckoning back again Cape *Codd* should be to the Northwards of the *Summer-Islands* 554 miles, and to the Eastwards 34 miles, whereas by the former reckonings outwards, it was to the Northwards only 487 miles, and to the Westwards 30 miles; so that the difference of these two reckonings outwards and back again is 67 miles Northerly, and 64 miles Easterly, which sheweth that the Current in that time, namely, in 9 dayes, hath set to the North-wards 67 miles, and to the Eastwards 64 miles; that is, Northeast little Northerly 93 miles, as by the fore-going Table doth appear, which is $10\frac{1}{3}$ miles every day.

And what we have here done by the Tables might have been done (as the fore-going Problemes) by the Doctrine of plain Triangles.

FINIS.

Books Printed and sold by George Hurlock, *at* St. Magnus-Church-Corner *in* Thames-Street, *neer* London Bridge.

Norwoods Doctrine of Triangles, with Logarithmes, lately Printed, exactly corrected, and much inlarged by the Author himself. *Norwood*'s Epitomy, applied to plain and Mercators Sailing.

Safeguard of Saylors, or great Rutter, by *Rob. Norman.*

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Seamans Dictionary, or the Exposition and Demonstration of all the parts and things belonging to a ship; together with an Explanation of all the Terms and Phrases used in the practique part of *Navigation*, by Sir *Henry Manwaring.*

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Seamans Glass, now newly published, with the addition of many propositions in *Navigation*, *Astronomy*, and *Dialling*, with an Appendix for the use of all Instruments that are used at Sea, and how to make their observation by them in North and South Latitudes, not before Printed.

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There is a new Book, called the *Pilots Sea-Mirror*, which is a *Compendium* of the largest *Wagoner.* There will shortly be Extant a new large Draught of the River of *Thames*, and all the Sands at the Rivers Mouth, and from the Downs, and Northwards as far as *Flamborough-head*, with a Description of all the Buoys and Beacons, Depths and Soundings all along the Coast, with all the necessary Sea-marks: very exactly done by *John Sellers*, and will be sold by him at his Shop at the *Hermitage* in Wapping, and by Mr. *Hurlock* at St. *Magnus Church* neer *London*-bridge.